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Research Article

Success of Grape (*Vitis vinifera L.*) Cuttings in Different Applications of Natural Growth Regulators and Origin of Cuttings Material

The Success of Grape (Vitis vinifera L.) Cuttings on Various Applications of Natural Growth Regulatory Substances and Cuttings Type

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ABSTRACT

This research was conducted to determine the success of grape cuttings in various applications of natural growth regulators and cutting types. The grafting operations were carried out from September 2022 to November 2022 at the greenhouse and Laboratory of Physiology and Plant Breeding, Diponegoro University. Research was performed using a completely randomized design (CRD) consisting of two factors. The first factor was the various natural growth regulator applications, namely shallot extract, coconut water, and cow urine, and the second factor was the type of cuttings: subapical and basal stems. Stems from sub-apical and basal portions were treated evenly with shallot extract, coconut water, and cow urine by the 3-hour dip method. Following this treatment, the cuttings were maintained, and the success of the grafting union was observed. The data showed that applications of natural growth regulators had significant effects on the success parameters of grape cuttings, such as the timing of shoot emergence, root length, number of roots, number of shoots, fresh weight of roots, and dry weight of roots. The type of grape cuttings has no effect on the success parameters of grape cuttings except for the fresh and dry weight of the roots. Based on this research, basal type and the application of shallot extract were recommended to promote the success of grape cuttings.

Keywords: *Cutting Types, Grape, Natural growth regulator*

INTRODUCTION

Grape *vines* (*Vitis vinifera* L.) are one of the horticultural commodities favored by some Indonesians. The high demand for grapes is not accompanied by the amount of grape production produced. Data from the Central Bureau of Statistics shows that grape production has decreased significantly every year. Grape production experienced significant fluctuations from 2017 to 2021. Grapes in 2018 experienced a decrease in production by 8% from 2017, in 2019 it increased by 15% from 2018, and in 2020 production again decreased by 14% from 2019 and production in 2021 increased by 6% from the previous year (BPS, 2021).

Grape (*Vitis vinifera* L.) is a commodity that needs to be developed because it has good prospects in Indonesia. The constraints in the development of grapevines are the availability of

planting material with good quality. One of the efforts to develop grapes is through improving propagation methods. Grapes can be propagated vegetatively, namely through stem cuttings (Lesmana *et al.,* 2018). The advantages of cuttings include that the plants produced are similar in terms of age, height, disease resistance to their parents and the resulting seedlings are also numerous.

Stem cuttings are one of the commonly used methods for vine propagation. Cuttings from different parts of the stem have different qualities because they undergo different developmental periods. This can affect the root growth of cuttings because it is related to the photosynthate transportation system in the stem. Young stems have low carbohydrate content but high hormone content so that the results of grafting will grow shoots first and the success rate is relatively low (Lesmana *et al.,* 2018). Good cuttings growth is that which produces roots first and has a balance of growth between roots and shoots. Cuttings taken from older plant parts show a high success rate. This is because the carbohydrate and auxin content is sufficient to support the rooting of cuttings. The base of the stem has a higher carbon content and food reserves than the middle and top so that the process of cell initiation and elongation can be accelerated (Fancora *et al.,* 2017). Increasing the success of propagation by stem cuttings is done by providing growth regulators (ZPT).

Plant regulators can be produced by the plant itself and often in small amounts, so the addition of external sources is required (Tustiyani, 2017). Shallots, cow urine, and old coconut water are natural ZPTs that can help the growth of grape cuttings. Shallot extract contains auxin and vitamin B1 to stimulate the early growth of stem cuttings (Aprilyani *et al.,* 2018). Shoot emergence time of plant cuttings can be accelerated with exogenous auxin stimulation (Asmi and Hadriatni, 2018). Beniwal *et al.* (2022) stated that the application of ZPT on grape cuttings affects the number of roots and root length of grape cuttings. The research conducted aims to determine the effect of the application of various kinds of natural ZPT and the origin of the cutting material on the success of grape cuttings observed.

MATERIALS AND METHODS

Time and place

The research will be conducted from September 2022 - November 2022 at the Green house of the Faculty of Animal Husbandry and Agriculture, Diponegoro University and the Laboratory of Plant Physiology and Breeding, Faculty of Animal Husbandry and Agriculture, Diponegoro University, Semarang.

Research Materials

The materials used were grape stems (Vitis vinifera L.) Jupiter variety, soil, husk charcoal, water, cow urine, shallots, young coconut water. The tools used in the study were shovels, polybags measuring 15 cm x 15 cm, 50% paranet, buckets, paddles, rulers, stationery, cell phones, blenders, filters, basins, labels, bottles, cuttings scissors, thermohygrometers, analytical scales, ovens.

Research Methods

This study used a 4x2 factorial design on the basis of a completely randomized design (CRD) with 4 replications, resulting in 8 combinations and 32 experimental units. The first factor is the application of various kinds of natural ZPT, there are 4 levels namely (Z0: without natural ZPT), (Z1: Onion extract), (Z2: Coconut water), (Z3: Cow urine). The second factor was the origin of the cutting material with 2 levels (B1: Center) and (B2: Base). Each experimental unit was planted with 2 cuttings so that 64 planting materials were needed. The area where the cuttings were placed was shaded with 50% paranet and the floor was watered every afternoon to reduce temperature and increase humidity.

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Initial research procedures were carried out with the preparation of planting media in the form of soil mixed with burnt husks in a ratio of 2: 1. The preparation of natural growth regulators of shallot extract was carried out by mashing 1 kg of shallots and filtered to obtain a 100% concentration of shallot extract, then 630 ml was taken and 70 ml of distilled water was added so as to obtain a 90% concentration of shallot extract. The 90% concentration of coconut water was obtained by mixing 900 ml of pure coconut water with distilled water. The 90% concentration of cow urine was made by mixing 900 ml of pure cow urine with 100 ml of distilled water. The preparation of grape stem cuttings was carried out from the middle and base of the tertiary stem with a length of approximately 15 cm and 3 buds then at the base cut obliquely by 450.

The center and base of the cuttings were then immersed in a container containing the solution according to the treatment for 3 hours to a depth of 4 cm. The cuttings were then planted 1/8th of the way into the media. Maintenance included watering in the morning and weed control by uprooting weeds that grew around the cuttings.

Observations of the success parameters of grape vine cuttings were made on shoot emergence time (HST), root length (cm), number of roots, number of shoots, root fresh weight (g), and root dry weight (g). *Data analysis*

The data obtained were analyzed using analysis of variance (F test) and if there was a significant effect on the treatment, it was continued with Duncan's Multiple Range Test (UJBD) at the 5% level.

RESULTS AND DISCUSSION

Shoot Emergence Time

The results of the analysis of variance showed that the treatment of natural growth regulators had a significant effect (P<0.05) on the time to shoot emergence of grape vine cuttings. The treatment of the origin of the cuttings material gave no significant effect (P>0.05) on the time to bud emergence of grape vine cuttings. There was an interaction between the treatment of natural growth regulators and the origin of the cutting material on the time to bud emergence. Based on Illustration 1, it is found that the fastest time of shoot emergence is in the treatment of stem origin of the base part which is given a natural ZPT of shallot extract.

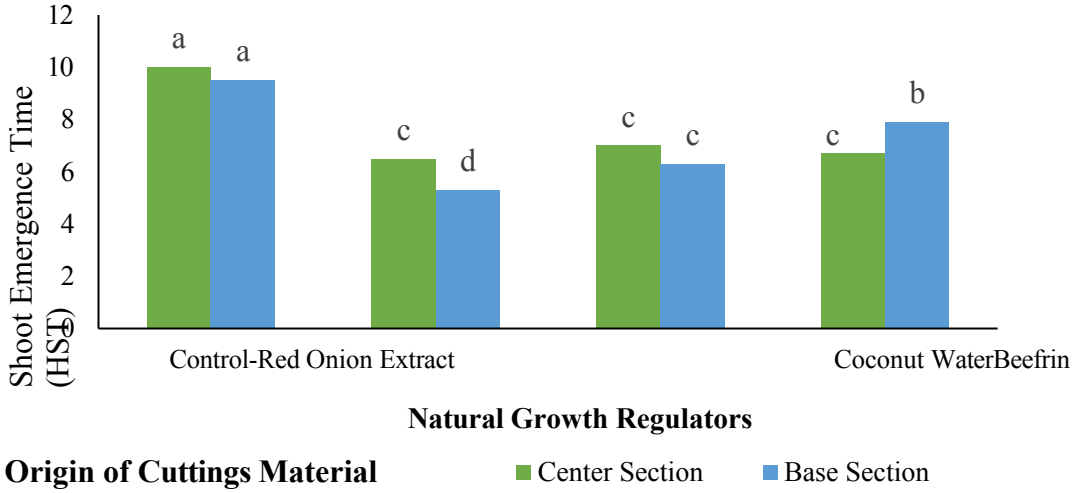

Illustration 1. Dry Weight of Grapevine Root Cuttings in the Treatment of Various Natural Growth Regulators and the Origin of Cuttings Material

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The shoot emergence time of grape cuttings based on research results can be accelerated by the application of natural ZPT. Exogenous natural auxin applied before the stem cuttings are planted is thought to be able to encourage shoot growth in plants. According to Juliantoro and Firgiyanto (2022), the application of exogenous auxin to grape cuttings will be absorbed by plant tissues and activate energy to encourage increased cell division and elongation which affects the time of bud emergence. Furthermore, Zhou *et al.* (2020) explained that exogenous auxin can increase the accumulation of auxin and zeatin riboside in the stem which plays a role in encouraging enzymes to degrade food reserves to produce energy so that accelerated budding and root initiation and growth can occur.

The results showed that the application of natural ZPT had a significant effect on the parameters of shoot emergence time of grapevine cuttings observed (Illustration 2). The best combination in shortening the time of shoot emergence is by combining the base of the stem and immersion in shallot extract (Z2B1). The treatment of the stem of the base part treated with shallot extract produced the best bud emergence time of 5.3 HST, which was significantly different from all the treatments observed. This is thought to be due to the content of food reserves in the stem of the base that is available enough, so that the provision of exogenous auxin treatment of shallots is able to stimulate the acceleration of shoot emergence better. Kaur and Kaur (2023) suggested that the absorption and utilization of hormones in the stem of the maximum base causes better budding and survival of cuttings. The auxin content present in shallots may also have a positive effect on the accumulation of endogenous auxin present in the base stem of grapevine cuttings.

Root Length

The results of the analysis of variance showed that the treatment of natural ZPT had a significant effect ($P<0.05$) on the length of the roots of grapevine cuttings. The treatment of the origin of the cutting material had no significant effect ($P>0.05$) on the length of the roots of grapevine cuttings. There was no interaction between the application of various natural growth regulators and the origin of the cutting material on the number of roots of grapevine stem cuttings. The results of Duncan's 5% further test on root length parameters are presented in Table 1.

Table 1. Root Length of Grapevine Cuttings with Application ofVarious Natural Growth Regulators and Origin of Cuttings Material

Natural ZPTs	Origin of cuttings		Average	
	Center Section	Base Section		
	(cm)			
Control	1,90	2,19	2,05	c
Red Onion Extract	3,08	2,89	2,98	a
Coconut Water	3,40	2,71	3,05	a
Cow Urine	2,81	2,83	2,82	b
Average	2,80	2,65		

Numbers followed by different letters in the average row indicate significantly different according to Duncan's test ($p < 0.05$).

Based on the results of Duncan's test, it was found that natural ZPT significantly affected the root length of grape vine cuttings (Table 1). The treatment of onion extract, coconut water and cow urine produced an average root length of 2.987 cm, 3.056 cm and 2.8822 cm, respectively. The control treatment produced a root length of 2.050 cm. These results indicate that the application of natural ZPT in the process of grape propagation by cuttings can increase root length due to the availability of exogenous hormones that are sufficient to encourage initiation and elongation.

roots. Diana (2014) stated that the application of natural ZPT contains exogenous auxin which is able to interact with endogenous auxin so that it can affect the length of the roots of grape vine cuttings. Wulandari *et al.* (2013) explained that coconut water contains cytokinins that can encourage cell division.

The root length of grape cuttings can be seen in Table 1, which shows that the application of natural ZPT has a significant effect on the root length parameter of grape cuttings. According to Hayati *et al.,* (2022) the provision of natural auxins shallot extract and coconut water has a significant effect on root length, number of roots, and shoot length of cuttings. Furthermore, Khair et al. (2013) in their research stated that rooting in plant cuttings generally occurs due to the influence of auxin produced by buds and leaves that have appeared, so that the provision of natural ZPT containing auxin from outside will cause better root production and elongation. Giving exogenous auxin coconut water and shallot extract used in the study with a concentration of 90% is thought to be optimal for supporting root growth. This is in line with the opinion of Aldi *et al.* (2017) which states that coconut water functions in softening the scelerenchymal cells in cuttings, but in excessive amounts it will damage and kill cells due to plasmolysis due to concentrations that are too concentrated.

Number of Roots

The results of the analysis of variance showed that the treatment of natural ZPT had a significant effect ($P<0.05$) on the number of roots of grapevine cuttings. The treatment of the origin of the cuttings material had no significant effect ($P>0.05$) on the root length of grape vine cuttings. The results of Duncan's 5% further test on root length parameters are presented in Table 2.

Table 2: Number of Roots of Grape Plant Cuttings with Different Applications of Natural Growth Regulators and Origin of Cuttings Material

Natural ZPTs	Origin of cuttings		Average	
	Section Middle	Section Base		
Control	2,40	2,35	2,37	b
Red Onion Extract	2,63	2,96	2,80	a
Coconut Water	2,77	3,01	2,89	a
Cow Urine	2,89	2,82	2,86	a
Average	2,67	2,78		

Numbers followed by different letters in the average row indicate significantly different according to Duncan's test ($p < 0.05$).

Duncan's further test of 5% in Table 4, shows that the control treatment (Z0) without natural ZPT with an average number of roots of 2.37 is significantly lower than the other treatments. The treatment of shallot extract (Z1), coconut water (Z2), and cow urine (Z3) produced an average number of roots of 2.80, 2.89 and 2.86, respectively. These results indicate that natural ZPTs provide exogenous auxins that encourage the initiation process and increase the quantity of roots on cuttings. Onion extract, coconut water, and cow urine may have some organic compounds that can stimulate root growth. Muswita (2011) states that in shallot extract there are several other hormone contents such as dihydroalin, methylalin, cycloalin, saponins, peptides, falvoglycosides, quercetin, as well as several vitamins and starch where these various contents are beneficial for plant metabolism. This is also reinforced by the opinion of Al ayyubi *et al.* (2019) which states that the formation of new roots and shoots on cuttings is influenced by many chemical groups, one of which is dihydroalin which functions in cell division in plants.

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Root Fresh Weight

The results of the analysis of variance showed that the application of various kinds of natural ZPT and the origin of the cutting material independently each had a significant effect on the fresh weight of the roots of grape vine cuttings. There was no interaction effect between the application treatment of various kinds of natural ZPT and the origin of the cuttings material on the observed root fresh weight parameters. The results of the 5% Duncan further test can be seen in Table 3.

Table 3. Fresh Weight of Grapevine Root Cuttings with Different Applications of Natural Growth Regulators and Origin of Cuttings Material

Natural ZPTs	Origin of cuttings				Average	
	Section Center		Base			
	---------- (g) ----------					
Control	0,64		0,77		0,70	c
Onion Extract						a
Red	0,87		1,17		1,02	
Coconut Water	0,82		0,90		0,86	b
Cow Urine	0,83		0,92		0,88	b
Average	0,79	b	0,94	a		

Numbers followed by different superscripts in the average row indicate significantly different according to Duncan's test ($p < 0.05$).

Based on the results of the 5% Duncan test, it was found that the application of natural ZPT and the origin of the cutting material had a significant effect ($P < 0.05$) on the fresh weight of the roots of grapevine cuttings (Table 8). The fresh weight of roots due to the application of natural ZPT of shallot extract (Z1), coconut water (Z2) and cow urine (Z3) resulted in an average fresh weight of roots of 1.02 g, 0.86 g, and 0.88 g, respectively, which was significantly different from the control treatment without natural ZPT (Z0) with an average fresh weight of roots of 0.70 g. The results showed that the application of natural ZPT had a positive effect on the fresh weight of roots. This shows that the application of natural ZPT has a positive effect on the fresh weight of the roots of grapevine cuttings. These results are in line with the research of Othman and Hawezy (2022) who reported that the application of natural ZPT significantly affects the parameters of improving the quality of rooting, namely the fresh weight and dry weight of roots, rooting percentage, and rooting index of grape vine cuttings. Furthermore, Singh and Chauhan (2020) added that adventitious rooting of grape cuttings is influenced by environmental conditions, exogenous and endogenous hormone content in plants, rooting media, and plant care.

The 5% Duncan test also showed that the base stem was better than the center stem in terms of fresh weight of roots. It is suspected that the carbohydrate content in the base of the stem affects the formation of root mass of vine cuttings. Kaur and Kaur (2023) stated that the base cuttings contain carbohydrates that are better for root initiation so that it affects the fresh weight of the roots. This is also supported by the opinion of Hartmann *et al.* (2015) which states that the content of good food reserves at the base of the stem can encourage the activation of cell division and increase root mass so that it affects the fresh weight of the roots.

Root Dry Weight

The results of the analysis of variance showed that the application of various kinds of natural ZPT and the origin of the cuttings material had a significant effect ($P < 0.05$) on the dry weight of the roots. There is an interaction between the application of various kinds of natural ZPT and the origin of the cuttings. Duncan test results can be seen in Illustration 2.

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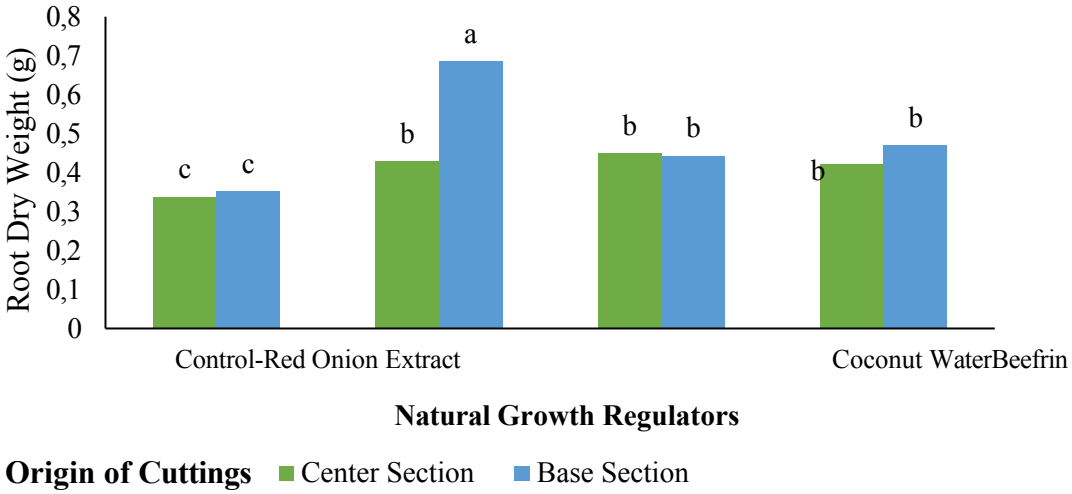

Illustration 2. Dry Weight of Grapevine Root Cuttings in the Treatment of Various Natural Growth Regulators and the Origin of Cuttings Material

Based on Illustration 2, there is an interaction effect between the application of various kinds of natural ZPT and the origin of the cutting material on the dry weight of the roots of the grapevine cuttings studied. The results of Duncan's further test at 5% (Table 9) showed that the interaction of the treatment of the center stem treated with natural ZPT was significantly different from the control (without natural ZPT). The center stem treated with natural ZPT of shallot extract (Z1B1), coconut water (Z1B2), and cow urine (Z1B3) successively produced an average root dry weight of 0.429 g; 0.450 g; and 0.423 g of vine cuttings. The control center cuttings (Z0B1) produced an average root dry weight of 0.338g. This shows that the application of natural ZPT can encourage root growth in cuttings. This result is in line with the report of Othman and Hawezy (2022) that the provision of natural ZPT is able to encourage the growth of grape cuttings roots well so as to increase the dry weight of roots per plant. According to Khair *et al.,* (2013) the exogenous auxin content of natural ZPT affects root elongation in cuttings better.

Based on the 5% Duncan's further test (Illustration 2), it was found that the combination of the treatment of the base of the stem and immersion in shallot extract is thought to be the most optimal so that it affects the formation of organic matter in the roots of vine cuttings better than other treatments. Setyawati and Andayani (2022) explained that the provision of exogenous auxin derived from shallot extract will encourage the growth and development of plant roots. The content of carbohydrates and nitrogen, as well as carbon (C) in the stem at the base is thought to be the best dry weight effect of the Z1B2 treatment combination on root dry weight parameters. This is in line with the opinion of Fancora *et al.* (2017) which states that the base of the stem has a higher carbon content than other parts, so that it can accelerate the initiation of the root mass formation process. Lesmana *et al.* (2018) explained that the high carbohydrate content at the base of the stem plays a role in the formation of root mass of plant cuttings.

CONCLUSIONS

Based on the results of the research, it can be concluded that the application of various kinds of natural ZPT and the origin of the cutting material can increase the success of grape vine cuttings in the parameters of shoot emergence time, number of roots, root length, root fresh weight, and root dry weight. Extra ZPT application

Onion at the base of the stem gives the best results on the success of vine cuttings with the fastest shoot emergence time and produces the best root dry weight.

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