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2	Penulis	**Fitra Gustiar*)**, Rofiqoh Purnama Ria, Nir Liansa Akram
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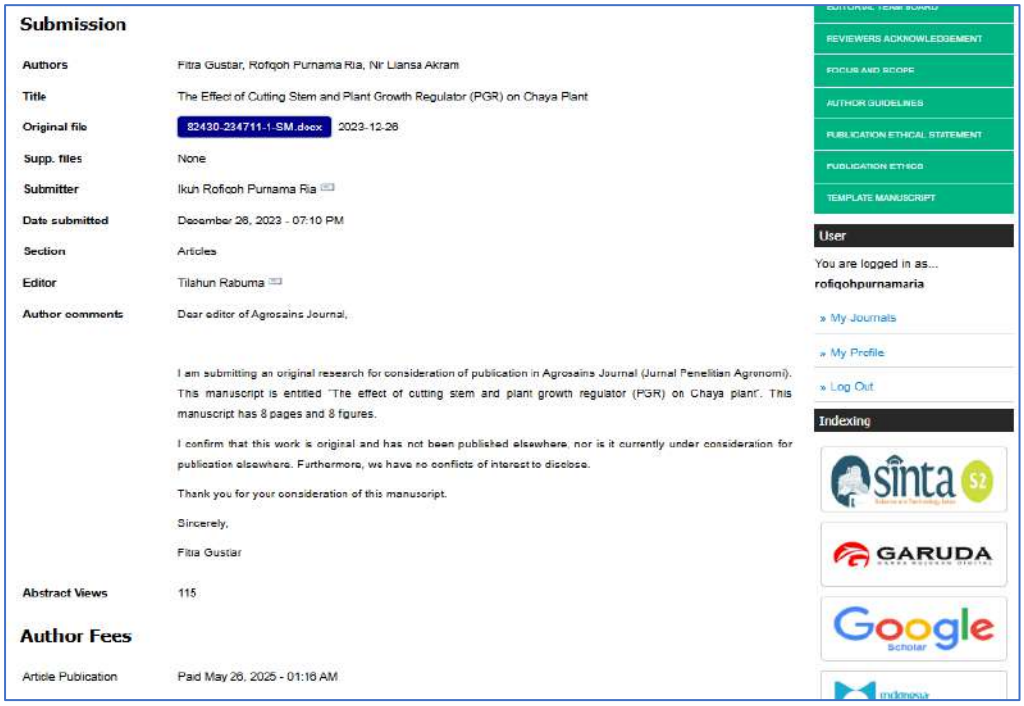

Submission

Authors	Fitra Gustiar, Rofiqoh Purnama Ria, Nir Liansa Akram
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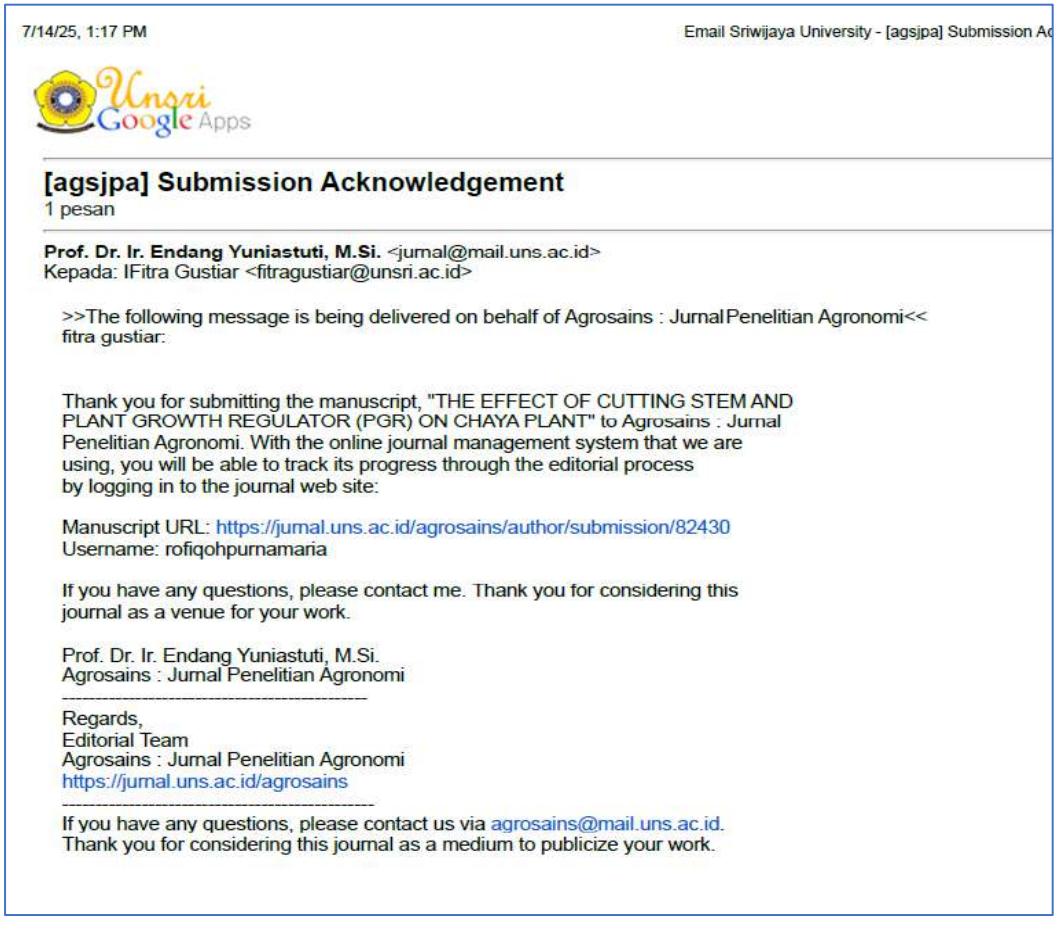

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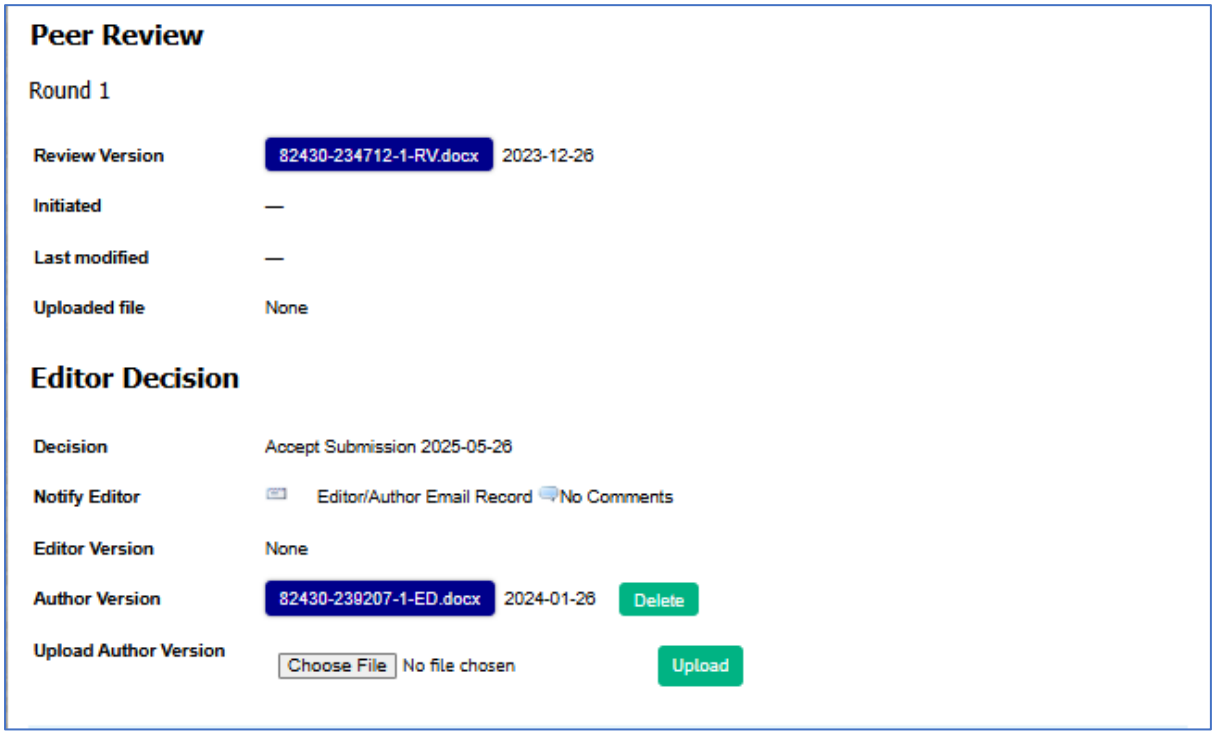

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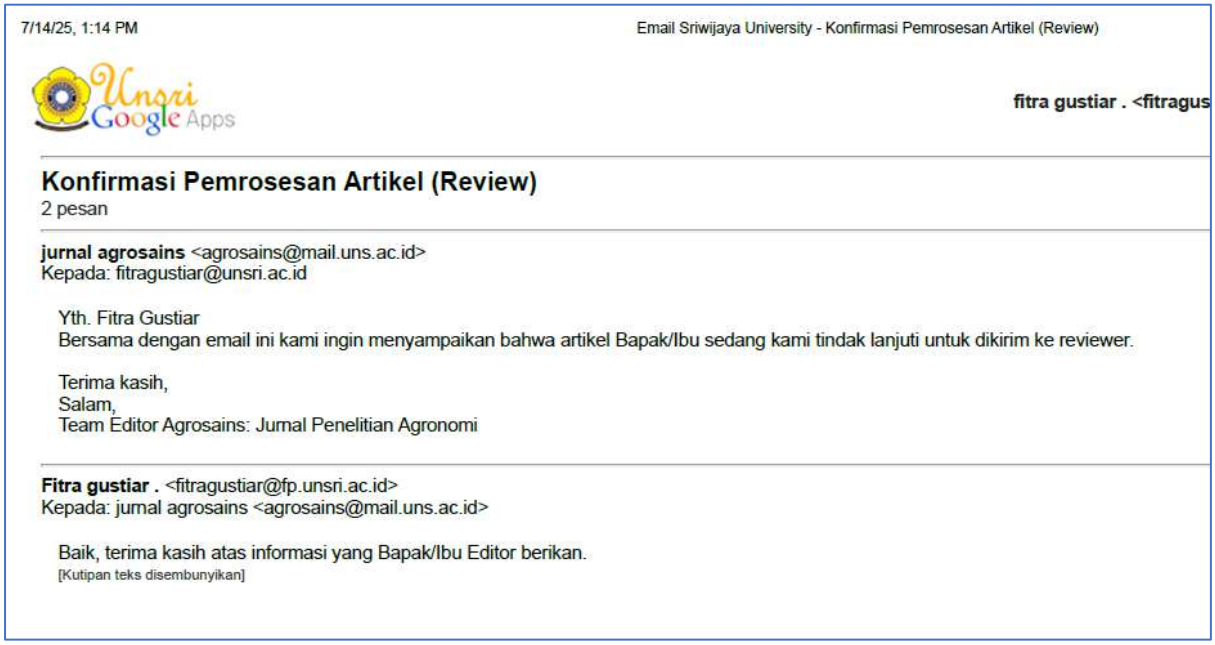

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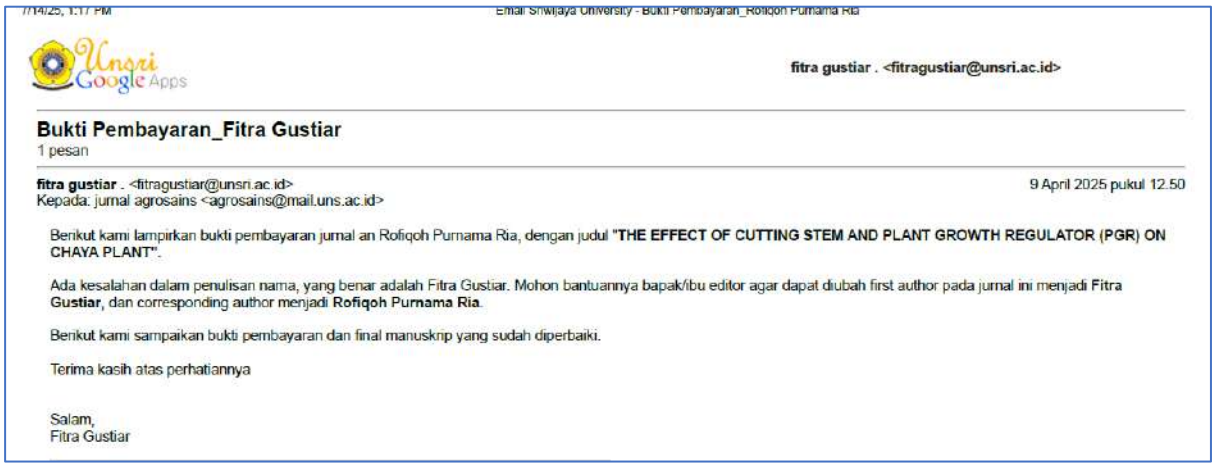

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Berikut kami lampirkan bukti pembayaran jurnal an Rofiqoh Purnama Ria, dengan judul **"THE EFFECT OF CUTTING STEM AND PLANT GROWTH REGULATOR (PGR) ON CHAYA PLANT"**.

Ada kesalahan dalam penulisan nama, yang benar adalah Fitra Gustiar. Mohon bantuannya bapak/ibu editor agar dapat diubah first author pada jurnal ini menjadi **Fitra Gustiar,** dan corresponding author menjadi **Rofiqoh Purnama Ria**.

Berikut kami sampaikan bukti pembayaran dan final manuskrip yang sudah diperbaiki.

Terima kasih atas perhatiannya

Salam,
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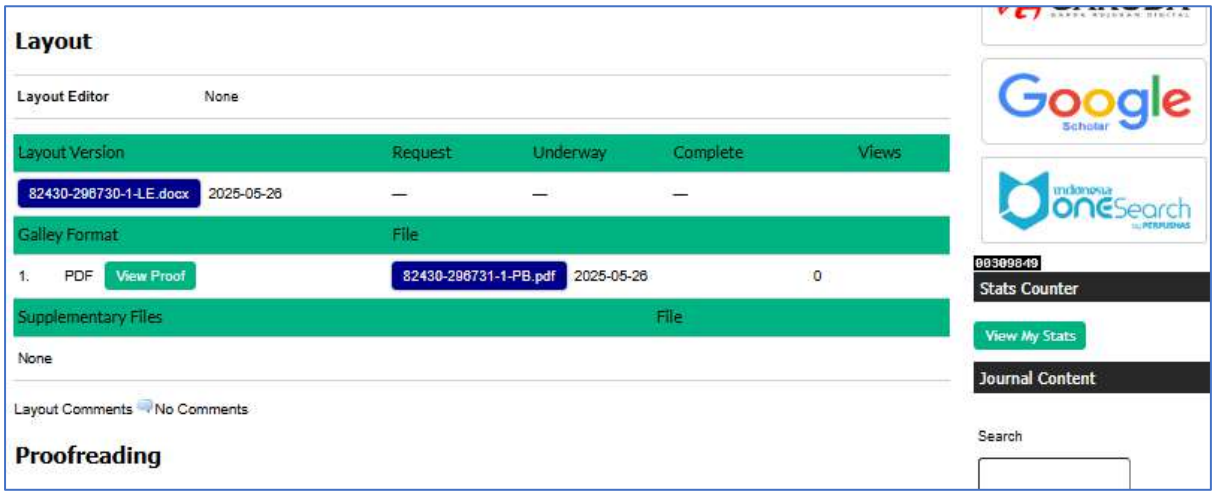

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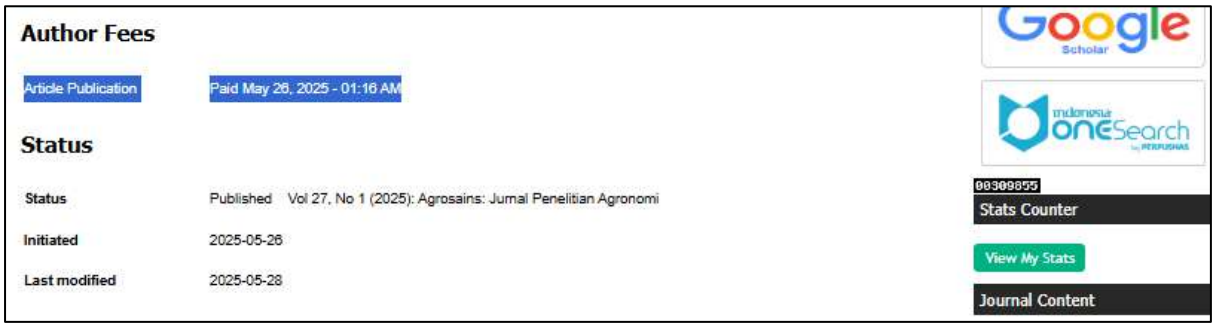

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I. Judul Manuskrip

THE EFFECT OF CUTTING STEM AND PLANT GROWTH REGULATOR (PGR) ON CHAYA PLANT

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Kebaharuan

This research provides information regarding the use of cuttings stem in chaya plants which have the potential to have better growth and yield. Furthermore, this research also provides information regarding PGR, namely onion extract, which can accelerate the emergence of shoots on chaya plant cuttings.

V. Kandidat reviewer (minimal 2 reviewer)

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THE EFFECT OF CUTTING STEM AND PLANT GROWTH REGULATOR (PGR) ON CHAYA PLANT

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ABSTRACT

Chaya (*Cnidoscolus aconitifolius*) Var. Picuda is an indigenous vegetable plant that is woody, drought resistant, and is generally propagated through vegetative propagation. Growth regulators greatly influence the growth of chaya plant cuttings. This research aims to determine the effect of giving natural plant growth regulator (PGR) to various sources of cutting material on the growth of chaya plants. This study used a two-factor randomized block design. The first factor is cutting stem i.e., top, middle and bottom stem and the second factor is growth regulators i.e. control, onion extract and coconut water extract. The research results showed that shallot extract had a positive influence on the emergence of shoots on chaya cuttings. Furthermore, the lower cutting planting material is either used as planting material for cuttings or for vegetative plant propagation. The bottom stem has sufficient food reserves and has an active bud growth point allowing the plant to grow and have a high growth success rate.

Keywords: Indigenous; chaya; onion extract; auxin

INTRODUCTION

The chaya plant or what is often known as Japanese papaya is native plant from Yucatan peninsula of Mexico. Chaya is a semi woody tree, drought tolerant and not require regular watering and other maintenance (Sudartini et al., 2020). Chaya plants are generally propagated vegetatively. The stem cutting materials used include top, middle and bottom stem (Gustiar et al., 2023a). However, the acceleration in growth is different because the auxin content contained in each part of the plant is different. The most auxin is found at the top of the plant. The further down or further from the top of the plant the auxin content decreases. Increasing the success of cutting stems can be done by using plant growth regulators (PGR) (Ramadan et al., 2016). Natural

growth regulators that can be used are onion extract (*Allium cepa* L) and coconut water (*Cocos nucifera*). Onion extract contain hormone auxin which can stimulate root growth in plant cuttings.

Onions contain the hormone auxin which can stimulate root growth in plant stems. In addition, in crushed onion the compound allithiamin will be formed. This compound can function to facilitate metabolism in plant tissues and can act as a fungicide and bactericide (Sofwan, 2018).

The use of coconut water in plant propagation is used to stimulate the formation of shoots and roots because it contains the hormones auxin and cytokinin (Febrianto et al., 2019). A coconut water concentration of 60% results in the fastest emergence time for red dragon fruit plant cuttings on average 3.58 days (Silawati and Syukri 2021). The use of plant growth regulator (PGR) will be effective at certain concentrations; If the concentration used is too high, it will damage the cuttings because cell division and callus will be excessive, thereby inhibiting the growth of flowers and roots, whereas if the concentration used is below optimum, the natural PGR will be ineffective. Therefore, this research aims to determine the effect of giving natural PGR to various sources of cutting material on the growth of chaya plants (Cnidoscolus aconitifolius).

BAHAN DAN METODE

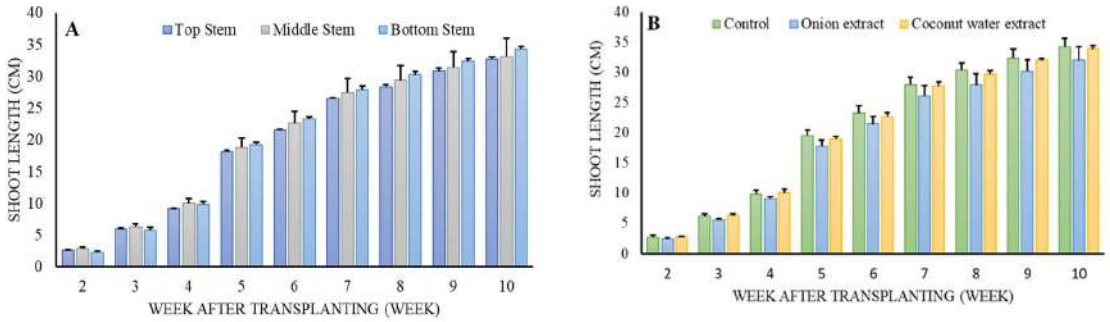
This research was carried out in experimental garden at Sriwijaya University, Inderalaya, South Sumatera. This research was used factorial randomized block design two factors. The first factor is plant growth regulators (PGR) i.e., control, onion extract and coconut extract. The second factor is cutting stem i.e., top, middle, bottom stem. The cutting stem materials were taken from chaya plant which age 12 months old with each cutting measuring 20 cm. The natural PGR used are shallot extract and coconut water with a concentration of 100%. Onion extract is made using 1 kg of blended onions. Meanwhile, coconut extract is taken from 1 liter of coconut water 100%. The planting medium used soil mixed with cow manure.

The percentage of shoot and stem emergence was calculated at week 4th. The leaves chlorophyl was measured using a SPAD meter every 3 days start from 32 days after planting. Dry weight accumulation was measured after the plant biomass oven-dried at 70 ºC for 48 hours.

Data analysis was used Microsoft excel and analysis of variance method with F table. If F hit > F table with a probability of F that is greater than 1%, then it is concluded that the treatment factor has a very significant effect, denoted by (**). If F hit > F table at a probability of F that is greater than 5%, then it is concluded that the treatment factor has a real effect, denoted by (*). If F hit < F Table, it means that the treatment factor has no significant effect, denoted by ns. The further test procedure used to determine the differences between treatments is the Least Significant Difference (LSL) test at a test level of 5%.

RESULT AND DISCUSSION

Growth of bottom stem showed slightly better growth, it can be seen from plant height and number of leaves in 4th and 10th week. Meanwhile, there was no significant difference on growth, chaya plants originating from the top stem showed higher growth. In fact, control treatment of PGR showed higher growth and yield than onion and coconut extract (Figure 1).



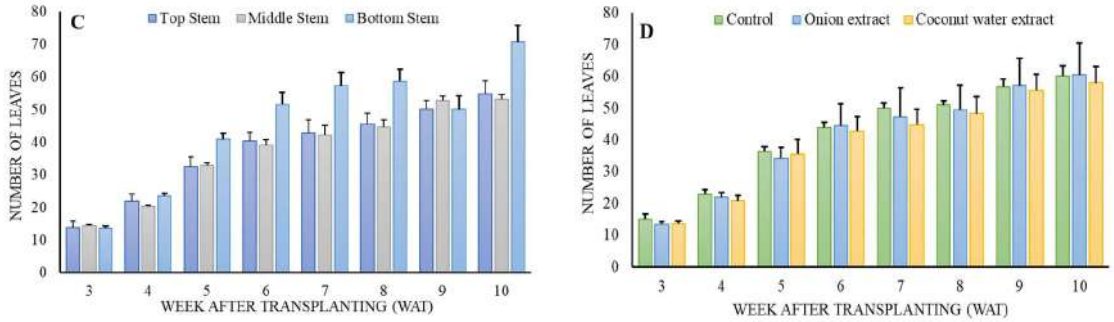


Figure 1. Shoot length and number of leaves in chaya plant affected by cutting stem (A-C) and extract growth inhibitors (B-D)

The effect of PGR showed on stem and shoot emergence percentage (Figure 2). Giving coconut water showed highest percentage stem and shoot emergence. In coconut water contains cytokinin and auxin which are higher so that these are quite influential in the formation of shoots and are able to encourage the formation of roots (Miftakhurrohmat and pujianti, 2020).The use of planting material originating from the bottom stem showed the highest percentage of stem and shoot emergence (Figure 2). Sudomo and Turjaman (2018) stated that the use of natural PGR with the highest concentration, namely 100%, gave the best results in terms of growth percentage and root and callus formation on shoot cuttings of Camelia japonica plants. 100% coconut water concentration has more optimal hormone content, so it is more effective in stimulating plant growth. This is also thought to be due to the hormone content in coconut water which is given to cuttings exogenously so that it can stimulate the plant's physiological processes.

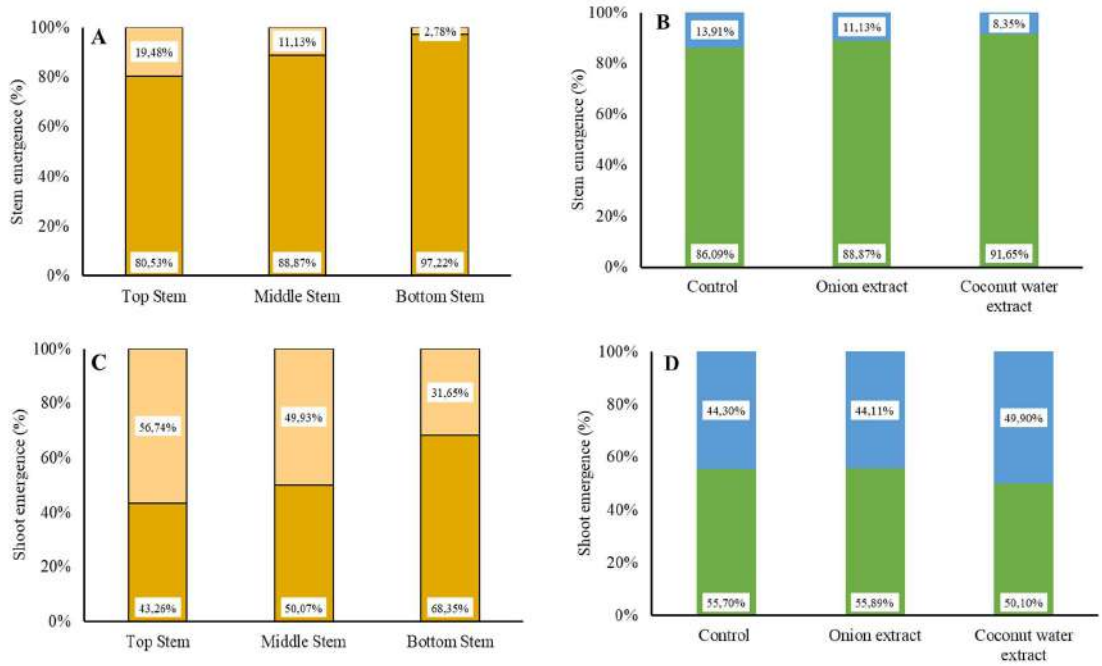


Figure 2. Stem and shoot emergence affected by stem cutting (A and C) and growing regulatory substances (B and D) in chaya plants

Cutting stem and PGR did not have a significant effect on the SPAD value. Gustiar et al (2023b) reported that there was no significant difference in the SPAD value of chaya plants. The SPAD value continuously increased from day 32 to 56. This shows that the SPAD of chaya plants consistently increased over the 6 days. So, it can be the basis for the right fertilization time for chaya plants.

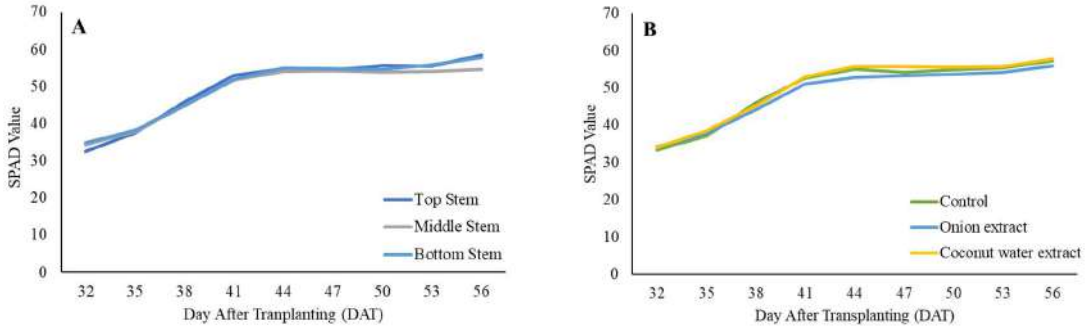


Figure 3. SPAD value on chaya plant affected by cutting stem (A) and extract growing regulatory substances (B) in chaya plants

Observations of leaf elongation and widening were carried out by measuring two samples of the same leaf continuously for up to 14 days. From the two samples measured, the chaya plants were shown to elongate and widen until they reached their maximum size on the 12th day. Furthermore, on days 13 and 14 there was no significant increase. This is the basis for the knowledge that chaya plant leaves can be harvested starting on the 12th day after the leaves fully open (Figure 4).

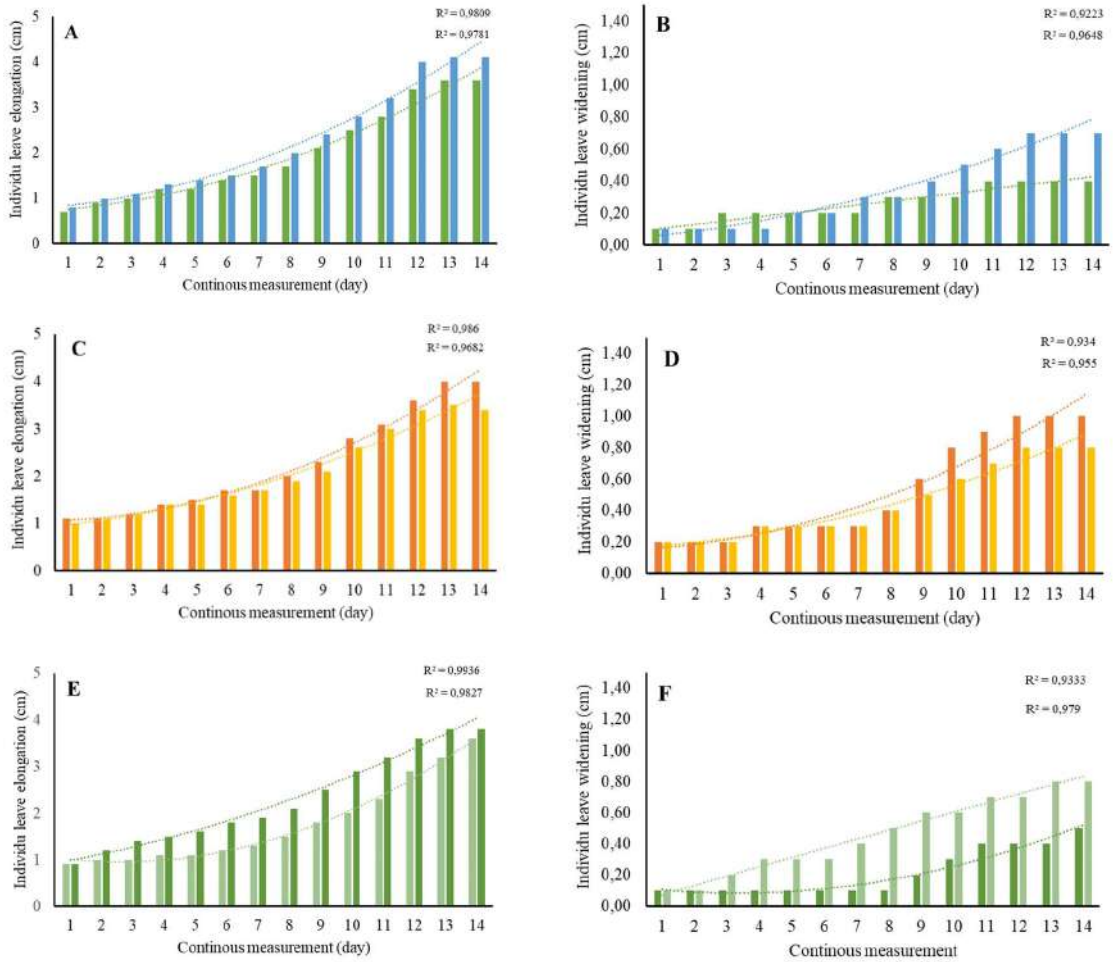


Figure 4. Individual leave elongation and widening affected by cutting stem i.e., top stem, middle stem, bottom stem (A, C, E), and extract growing regulatory substances i.e., control, extract onion, extract coconut water (B, D, F) in chaya plant

There was no significant difference between canopy area and shoot diameter in both the cutting stem and ZPT extract treatments (Figure 5). The effect of cutting stem was not visible on the number of branches, but did not differ significantly on the number of shoots. Furthermore, onion extract stimulates branch growth so that it has a greater number of branches (Figure 6). This occurs allegedly because the auxin content is higher in cuttings

taken from the middle part. The middle planting material is also good for planting cuttings or vegetative plant propagation because the stem in the middle is neither too young nor too old. In this part, apart from having sufficient food reserves, it also has active shoot growth points that enable plants to grow, the success rate is high (Suryanti et al., 2022). Wathan (2022) reported that growing patchouli cuttings of the Lhokseumawe variety using a concentration of shallot extract resulted in better plant growth.

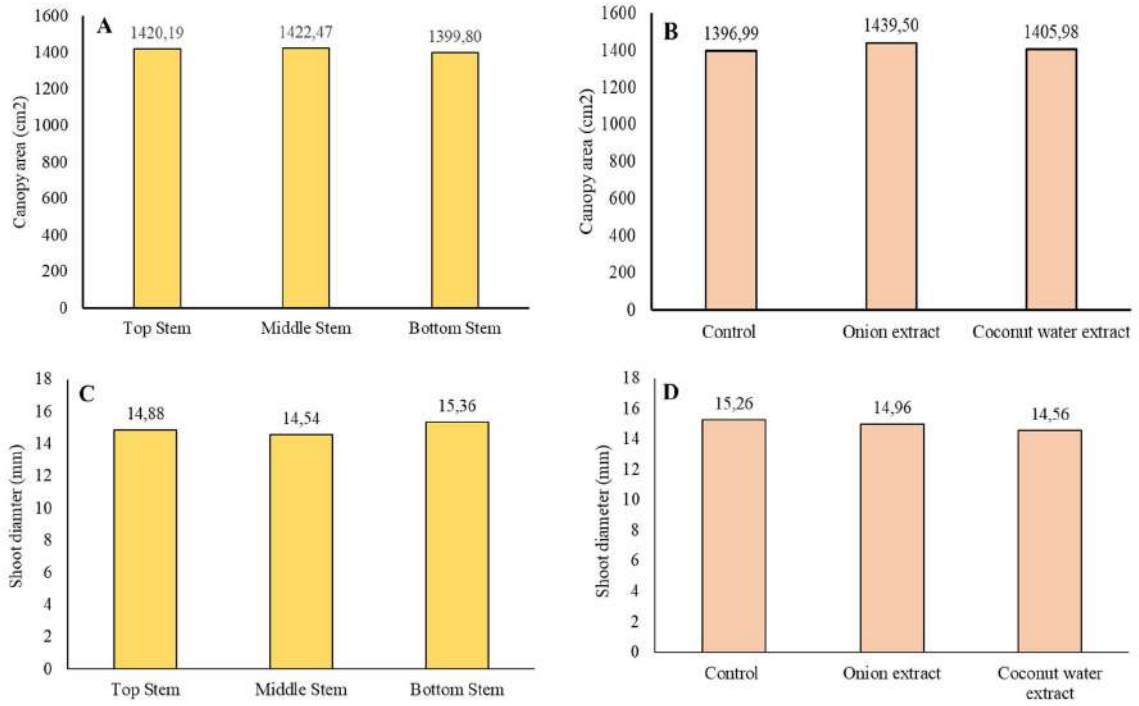


Figure 5. Shoot diameter affected by cutting stem (A-C) and extract growing regulatory substances (B-D) in Chaya plant

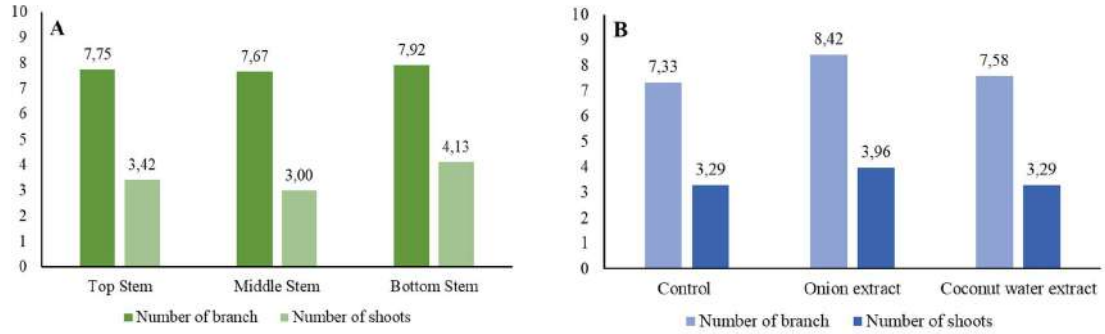


Figure 6. Number of branch and number of shoots on chaya plants affected by cutting stem (A) and extract growing regulatory substances (B).

Root formation is the main problem in propagation by cuttings, because the appearance of roots is an indication of whether the cutting was successful or not. The faster and more roots are formed, the greater the possibility of obtaining better results and being more resistant to unfavorable environmental conditions. The top stem has a longer root (Figure 7). Interestingly, Susilawati (2014) stated that stem cuttings from the bottom stem had the best effect on the number of roots, root length and dry weight of the roots.

Furthermore, giving onion extract also stimulates root growth, so that the chaya roots are longer. Good root growth will result in shoot growth as well (Figure 7). The auxin produced by onion extract influences the formation of root tissue in cuttings, while the formation of shoots is assisted by cytokinins. According to Martana et al. (2020), the right concentration of auxin in cells can increase osmotic pressure, increase cell permeability so that it can increase the diffusion of water and nutrients into the cells, so that by increasing the concentration of auxin in plants, it can activate root formation.

The ease of adventitious root formation is closely related to the concentration of natural PGR formed in the plant body, thus there is a close relationship between PGR and the ability of the cuttings to grow roots. The cutting material used, the growing environment and the treatment given to the cutting material are factors that influence shoot growth (Prastowo et al., 2006). Good cuttings are those that are able to produce balanced roots and shoots. The formation of cutting roots requires energy in the form of carbohydrates and proteins stored in the original planting material.

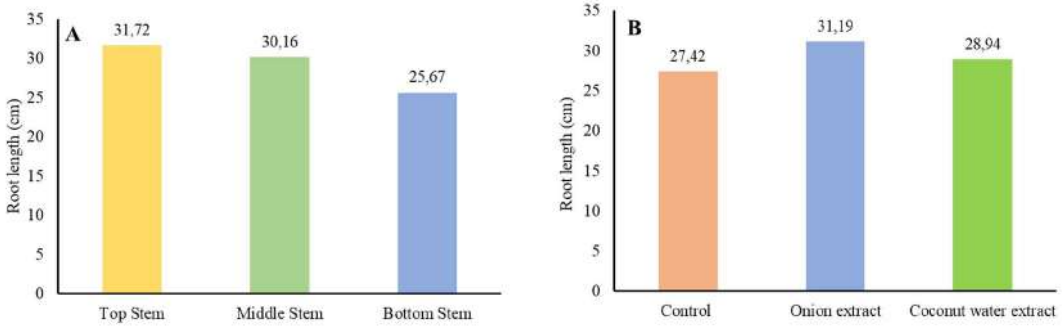
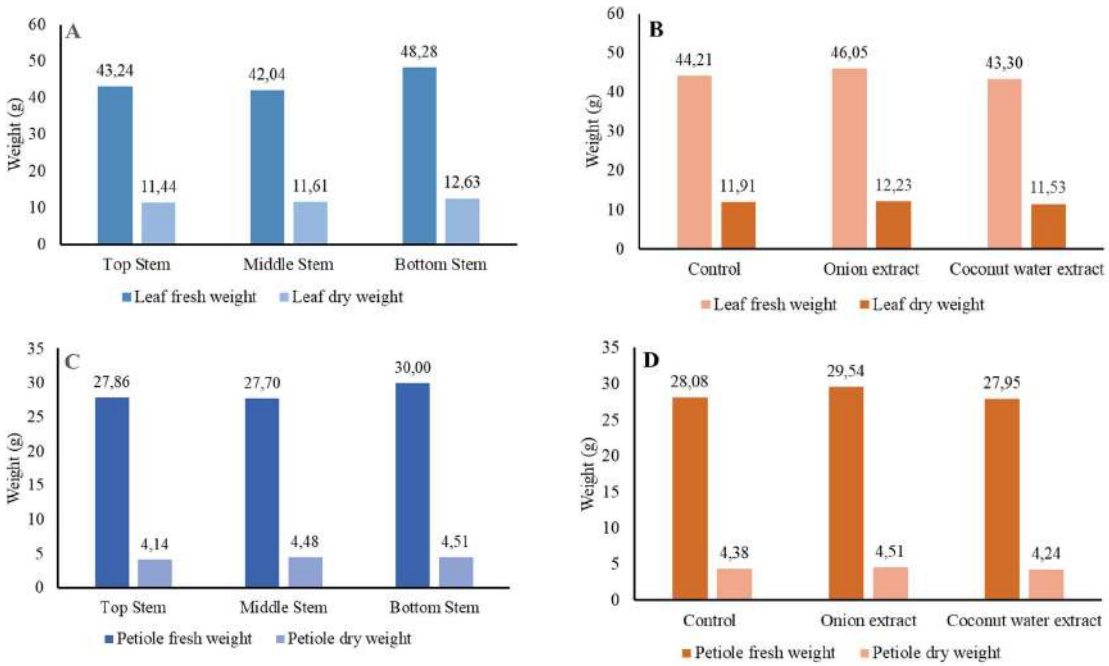


Figure 7. Root length of chaya plant affected by cutting stem (A) and extract growing regulatory substances (B).

Bottom stem produces fresh weight of leaves, petiole and stem higher than top and middle stem. However, interestingly, the bottom stem has a lower fresh root weight. It indicated that the roots of plants planted using bottom stem planting material have slower root growth than top and middle ones. Furthermore, although there were no significant differences between PGR extract treatments. However, onion extract showed a higher fresh weight than control and coconut water extract (Figure 8).



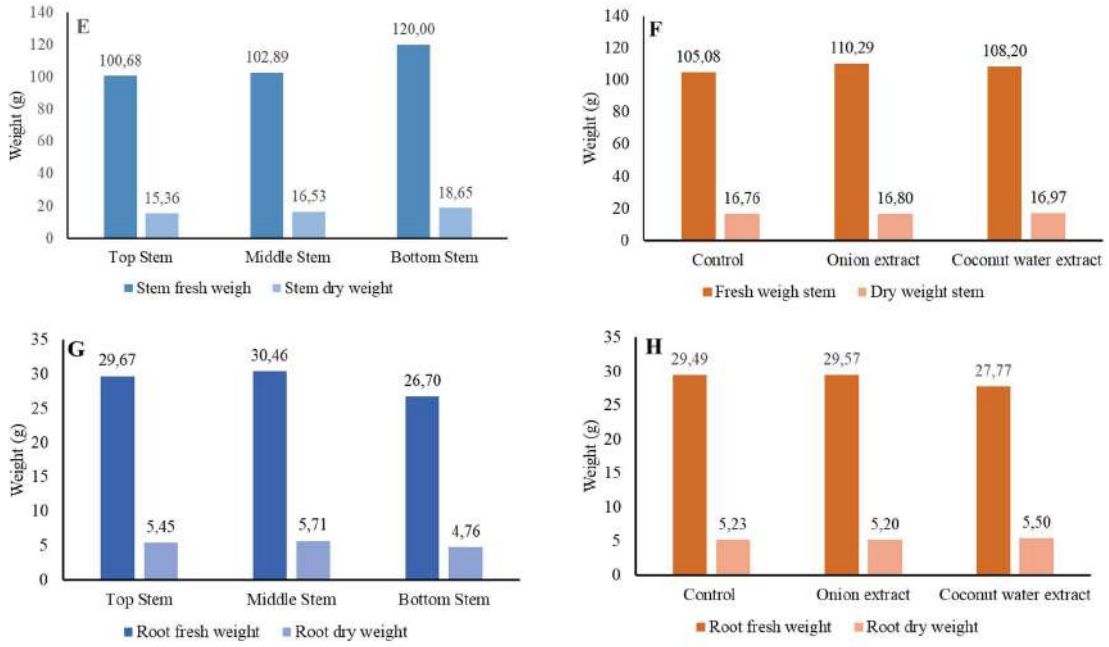


Figure 8. Fresh and dry weight on leaf, petiole, stem and root chaya plants affected by cutting stem (A, C, E, and G) and extract growing regulatory substances (B, D, F, and H).

The dry weight of the plant is the total weight of the plant after being dried in the oven, so that the water content has been lost and what remains are only the chemical compounds contained in the plant. According to Affrilah et al (2020) plant biomass indicates the number of chemical compounds contained in the plant, the higher the biomass, the more chemical compounds it contains, thereby increasing the dry weight of the plant. Plant dry weight is closely related to three processes, namely the fertilization process of assimilate through photosynthesis, a decrease in assimilate through the respiration process and a decrease in assimilate due to accumulation in storage.

CONCLUSION

Chaya plants propagated using bottom stem planting material showed the best growth and results including number of leaves, fresh weight of leaves. The optimal time to harvest chaya leaves is 12 days after the leaves fully open. Onion extract can increase the percentage of shoot and stem emergence, increase the number of branches, number of leaves, fresh leaf weight and root length.

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Review

THE EFFECT OF CUTTING STEM AND PLANT GROWTH REGULATOR (PGR) ON CHAYA PLANT

ABSTRACT

Chaya (*Cnidoscolus aconitifolius*) Var. Picuda is an indigenous vegetable plant that is woody, drought resistant, and is generally propagated through vegetative propagation. Growth regulators greatly influence the growth of chaya plant cuttings. This research aims to determine the effect of giving natural plant growth regulator (PGR) to various sources of cutting material on the growth of chaya plants. This study used a two-factor randomized block design. The first factor is cutting stem i.e., top, middle and bottom stem and the second factor is growth regulators i.e. control, onion extract and coconut water extract. The research results showed that shallot extract had a positive influence on the emergence of shoots on chaya cuttings. Furthermore, the lower cutting planting material is either used as planting material for cuttings or for vegetative plant propagation. The bottom stem has sufficient food reserves and has an active bud growth point allowing the plant to grow and have a high growth success rate.

Keywords: Indigenous; chaya; onion extract; auxin

Commented [NL1]: Add the influence of PGR extract on the abstract

INTRODUCTION

The chaya plant or what is often known as Japanese papaya is native plant from Yucatan peninsula of Mexico. Chaya is a semi woody tree, drought tolerant and not require regular watering and other maintenance (Sudartini et al., 2020). Chaya plants are generally propagated vegetatively. The stem cutting materials used include top, middle and bottom stem (Gustiar et al., 2023a). However, the acceleration in growth is different because the auxin content contained in each part of the plant is different. The most auxin is found at the top of the plant. The further down or further from the top of the plant the auxin content decreases. Increasing the success of cutting stems can be done by using plant growth regulators (PGR) (Ramadan et al., 2016). Natural growth regulators that can be used are onion extract (*Allium cepa* L) and coconut water (*Cocos nucifera*). Onion extract contain hormone auxin which can stimulate root growth in plant cuttings.

Commented [NL2]: Please add reference about chaya plant

Commented [NL3]: What are the ways to propagate it?

Onions contain the hormone auxin which can stimulate root growth in plant stems. In addition, in crushed onion the compound allithiamin will be formed. This compound can function to facilitate metabolism in plant tissues and can act as a fungicide and bactericide (Sofwan, 2018).

Commented [NL4]: add references to the benefits of PGPR on other cutting plants

The use of coconut water in plant propagation is used to stimulate the formation of shoots and roots because it contains the hormones auxin and cytokinin (Febrianto et al., 2019). A coconut water concentration of 60% results in the fastest emergence time for red dragon fruit plant cuttings on average 3.58 days (Silawati and Syukri 2021). The use of plant growth regulator (PGR) will be effective at certain concentrations; If the concentration used is too high, it will damage the cuttings because cell division and callus will be excessive, thereby inhibiting the growth of flowers and roots, whereas if the concentration used is below optimum, the natural PGR will be ineffective. Therefore, this research aims to determine the effect of giving natural PGR to various sources of cutting material on the growth of chaya plants (Cnidoscolus aconitifolius).

BAHAN DAN METODE

This research was carried out in experimental garden at Sriwijaya University, Inderalaya, South Sumatera. This research was used factorial randomized block design two factors. The first factor is plant growth regulators (PGR) i.e., control, onion extract and coconut extract. The second factor is cutting stem i.e., top, middle, bottom stem. The cutting stem materials were taken from chaya plant which age 12 months old with each cutting measuring 20 cm. The natural PGR used are shallot extract and coconut water with a concentration of 100%.

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Onion extract is made using 1 kg of blended onions. Meanwhile, coconut extract is taken from 1 liter of coconut water 100%. The planting medium used soil mixed with cow manure.

The percentage of shoot and stem emergence was calculated at week 4th. The leaves chlorophyl was measured using a SPAD meter every 3 days start from 32 days after planting. Dry weight accumulation was measured after the plant biomass oven-dried at 70 ºC for 48 hours.

Data analysis was used Microsoft excel and analysis of variance method with F table. If F hit > F table with a probability of F that is greater than 1%, then it is concluded that the treatment factor has a very significant effect, denoted by (**). If F hit > F table at a probability of F that is greater than 5%, then it is concluded that the treatment factor has a real effect, denoted by (*). If F hit < F Table, it means that the treatment factor has no significant effect, denoted by ns. The further test procedure used to determine the differences between treatments is the Least Significant Difference (LSL) test at a test level of 5%.

RESULT AND DISCUSSION

Growth of bottom stem showed slightly better growth, it can be seen from plant height and number of leaves in 4th and 10th week. Meanwhile, there was no significant difference on growth, chaya plants originating from the top stem showed higher growth. In fact, control treatment of PGR showed higher growth and yield than onion and coconut extract (Figure 1).

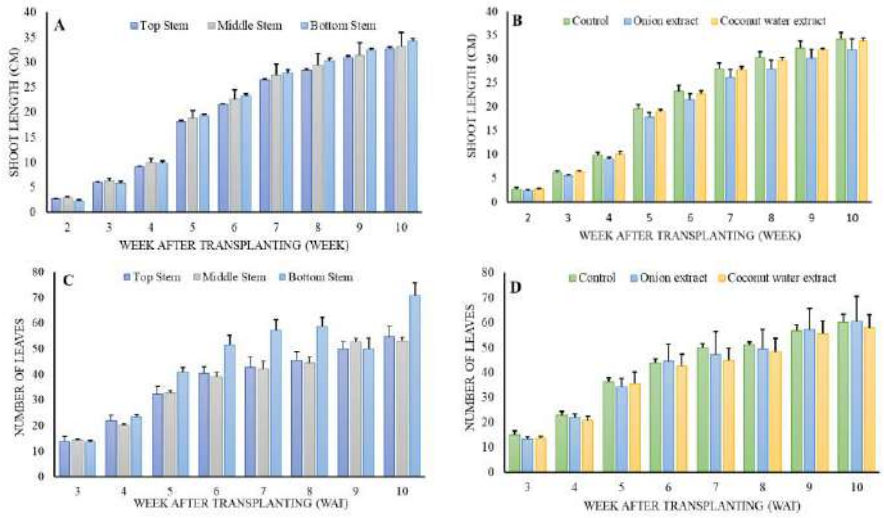

Figure 1. Shoot length and number of leaves in chaya plant affected by cutting stem (A-C) and extract growth inhibitors (B-D)

The effect of PGR showed on stem and shoot emergence percentage (Figure 2). Giving coconut water showed highest percentage stem and shoot emergence. In coconut water contains cytokinin and auxin which are higher so that these are quite influential in the formation of shoots and are able to encourage the formation of roots (Miftakhurrohmat and pujianti, 2020).The use of planting material originating from the bottom stem showed the highest percentage of stem and shoot emergence (Figure 2). Sudomo and Turjaman (2018) stated that the use of natural PGR with the highest concentration, namely 100%, gave the best results in terms of growth percentage and root and callus formation on shoot cuttings of Camelia japonica plants. 100% coconut water concentration has more optimal hormone content, so it is more effective in stimulating plant growth. This is also thought to be due to the hormone content in coconut water which is given to cuttings exogenously so that it can stimulate the plant's physiological processes.

Commented [NL6]: Add the type of soil used

Commented [NL7]: Please add reference effect of PGR on growth chaya plant

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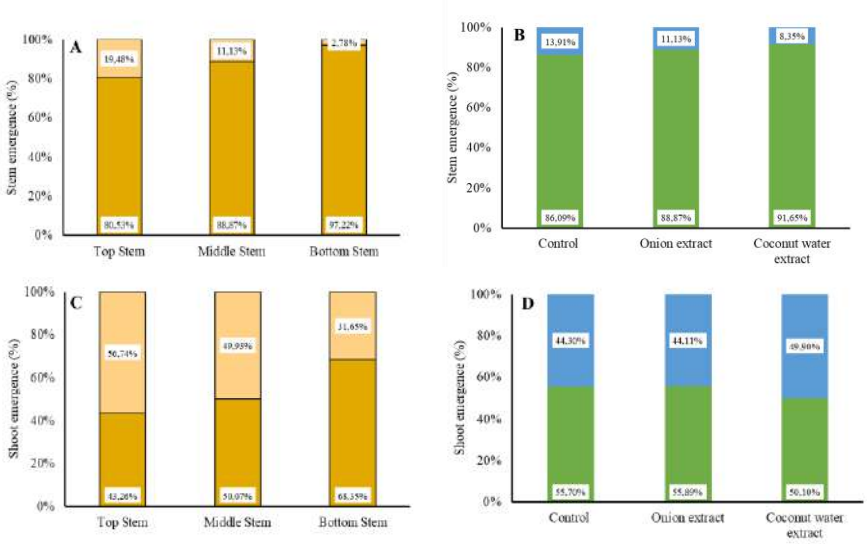

Figure 2. Stem and shoot emergence affected by stem cutting (A and C) and growing regulatory substances (B and D) in chaya plants

Cutting stem and PGR did not have a significant effect on the SPAD value. Gustiar et al (2023b) reported that there was no significant difference in the SPAD value of chaya plants. The SPAD value continuously increased from day 32 to 56. This shows that the SPAD of chaya plants consistently increased over the 6 days. So, it can be the basis for the right fertilization time for chaya plants.

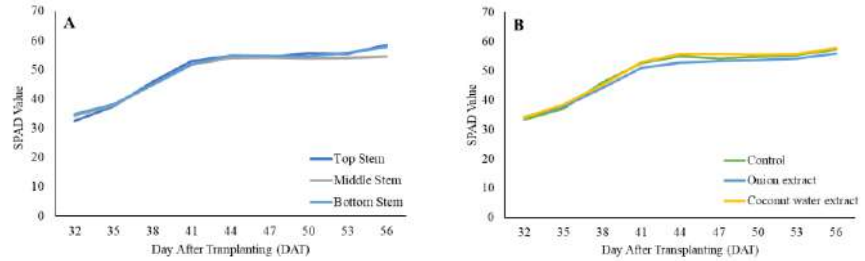

Figure 3. SPAD value on chaya plant affected by cutting stem (A) and extract growing regulatory substances (B) in chaya plants

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Observations of leaf elongation and widening were carried out by measuring two samples of the same leaf continuously for up to 14 days. From the two samples measured, the chaya plants were shown to elongate and widen until they reached their maximum size on the 12th day. Furthermore, on days 13 and 14 there was no significant increase. This is the basis for the knowledge that chaya plant leaves can be harvested starting on the 12th day after the leaves fully open (Figure 4).

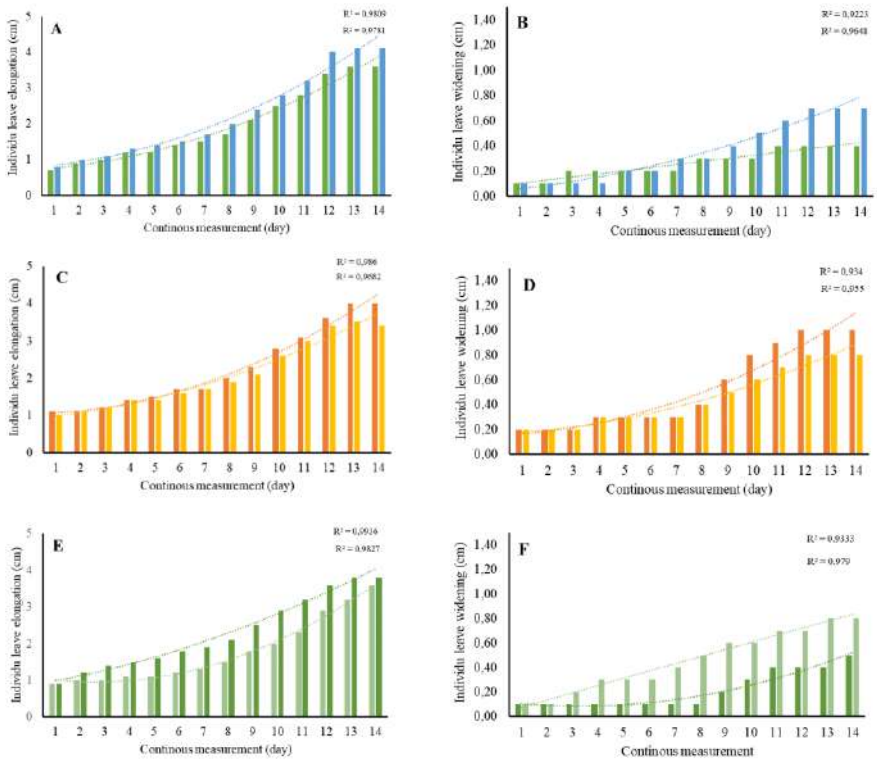
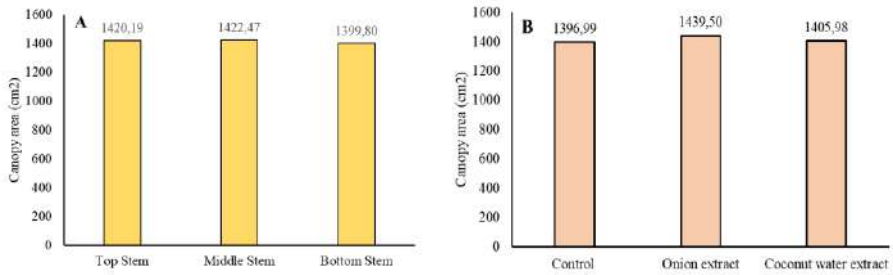


Figure 4. Individual leave elongation and widening affected by cutting stem i.e., top stem, middle stem, bottom stem (A, C, E), and extract growing regulatory substances i.e., control, extract onion, extract coconut water (B, D, F) in chaya plant

There was no significant difference between canopy area and shoot diameter in both the cutting stem and ZPT extract treatments (Figure 5). The effect of cutting stem was not visible on the number of branches, but did not differ significantly on the number of shoots. Furthermore, onion extract stimulates branch growth so that it has a greater number of branches (Figure 6). This occurs allegedly because the auxin content is higher in cuttings taken from the middle part. The middle planting material is also good for planting cuttings or vegetative plant propagation because the stem in the middle is neither too young nor too old. In this part, apart from having sufficient food reserves, it also has active shoot growth points that enable plants to grow, the success rate is high (Suryanti et al., 2022). Wathan (2022) reported that growing patchouli cuttings of the Lhokseumawe variety using a concentration of shallot extract resulted in better plant growth.



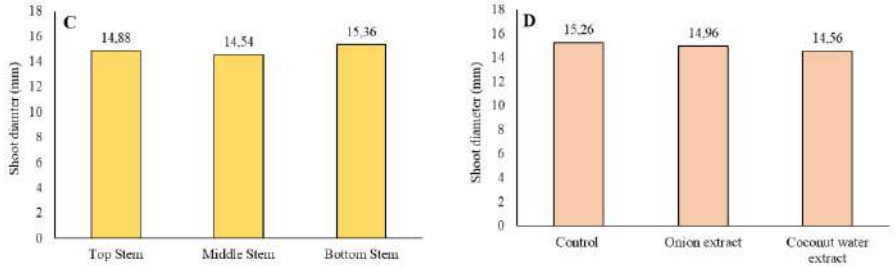


Figure 5. Shoot diameter affected by cutting stem (A-C) and extract growing regulatory substances (B-D) in Chaya plant

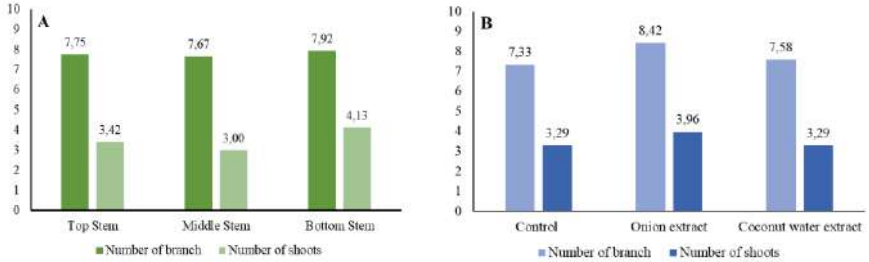


Figure 6. Number of branch and number of shoots on chaya plants affected by cutting stem (A) and extract growing regulatory substances (B).

Root formation is the main problem in propagation by cuttings, because the appearance of roots is an indication of whether the cutting was successful or not. The faster and more roots are formed, the greater the possibility of obtaining better results and being more resistant to unfavorable environmental conditions. The top stem has a longer root (Figure 7). Interestingly, Susilawati (2014) stated that stem cuttings from the bottom stem had the best effect on the number of roots, root length and dry weight of the roots.

Furthermore, giving onion extract also stimulates root growth, so that the chaya roots are longer. Good root growth will result in shoot growth as well (Figure 7). The auxin produced by onion extract influences the formation of root tissue in cuttings, while the formation of shoots is assisted by cytokinins. According to Martana et al. (2020), the right concentration of auxin in cells can increase osmotic pressure, increase cell permeability so that it can increase the diffusion of water and nutrients into the cells, so that by increasing the concentration of auxin in plants, it can activate root formation.

The ease of adventitious root formation is closely related to the concentration of natural PGR formed in the plant body, thus there is a close relationship between PGR and the ability of the cuttings to grow roots. The cutting material used, the growing environment and the treatment given to the cutting material are factors that influence shoot growth (Prastowo et al., 2006). Good cuttings are those that are able to produce balanced roots and shoots. The formation of cutting roots requires energy in the form of carbohydrates and proteins stored in the original planting material.

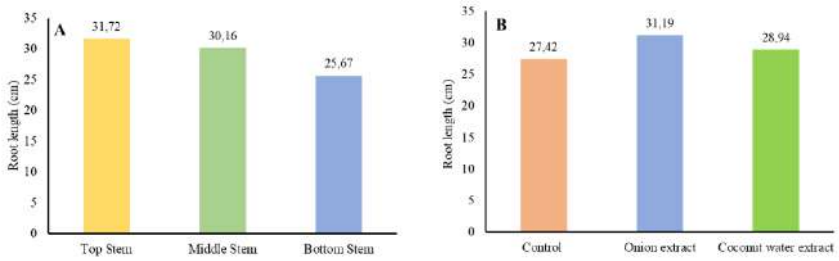
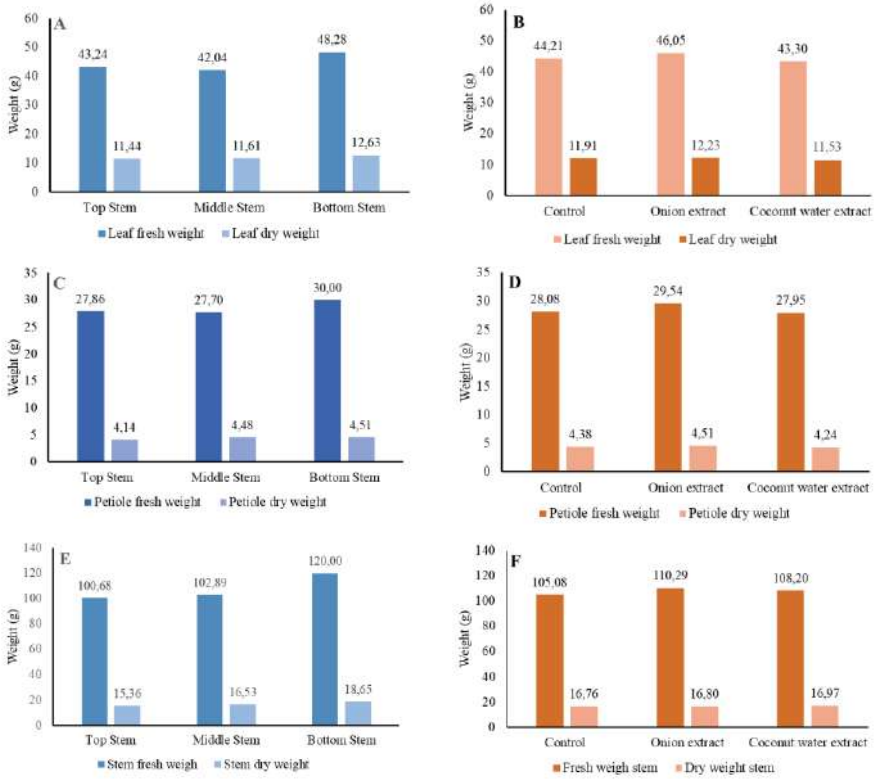


Figure 7. Root length of chaya plant affected by cutting stem (A) and extract growing regulatory substances (B).

Bottom stem produces fresh weight of leaves, petiole and stem higher than top and middle stem. However, interestingly, the bottom stem has a lower fresh root weight. It indicated that the roots of plants planted using bottom stem planting material have slower root growth than top and middle ones. Furthermore, although there were no significant differences between PGR extract treatments. However, onion extract showed a higher fresh weight than control and coconut water extract (Figure 8).



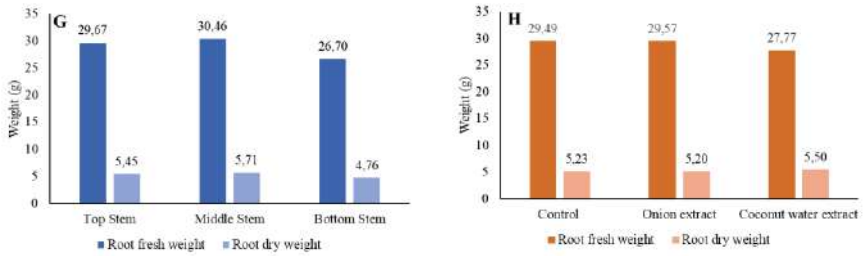


Figure 8. Fresh and dry weight on leaf, petiole, stem and root chaya plants affected by cutting stem (A, C, E, and G) and extract growing regulatory substances (B, D, F, and H).

The dry weight of the plant is the total weight of the plant after being dried in the oven, so that the water content has been lost and what remains are only the chemical compounds contained in the plant. According to Affrilah et al (2020) plant biomass indicates the number of chemical compounds contained in the plant, the higher the biomass, the more chemical compounds it contains, thereby increasing the dry weight of the plant. Plant dry weight is closely related to three processes, namely the fertilization process of assimilate through photosynthesis, a decrease in assimilate through the respiration process and a decrease in assimilate due to accumulation in storage.

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CONCLUSION

Chaya plants propagated using bottom stem planting material showed the best growth and results including number of leaves, fresh weight of leaves. The optimal time to harvest chaya leaves is 12 days after the leaves fully open. Onion extract can increase the percentage of shoot and stem emergence, increase the number of branches, number of leaves, fresh leaf weight and root length.

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File Revisi

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Keywords: Indigenous; chaya; onion extract; auxin

INTRODUCTION

The chaya plant or what is often known as Japanese papaya is native plant from Yucatan peninsula of Mexico. Chaya is considered a neglected and underutilized crop owing to limited general knowledge about it, its poor representation in ex situ collections, and the lack of conservation programs (Munguía-Rosas et al., 2019). Chaya is a semi woody tree, drought tolerant and not require regular watering and other maintenance (Sudartini et al., 2020). Chaya plants are generally propagated vegetatively i.e., grafting, cuttings and grafting. The stem cutting materials used include top, middle and bottom stem (Gustiar et al., 2023a). However, the acceleration in growth is different because the auxin content contained in each part of the plant is different. The most auxin is found at the top of the plant. The further down or further from the top of the plant the auxin content decreases. Increasing the success of cutting stems can be done by using plant growth regulators (PGR) (Ramadan et al., 2016). Natural growth regulators that can be used are onion extract (*Allium cepa* L) and coconut water (*Cocos nucifera*). Onion extract contain hormone auxin which can stimulate root growth in plant cuttings.

Onions contain the hormone auxin which can stimulate root growth in plant stems. In addition, in crushed onion the compound allithiamin will be formed. This compound can function to facilitate metabolism in plant tissues and can act as a fungicide and bactericide (Sofwan, 2018). Based on research results, shallot extract can increase the percentage of living coffee plant cuttings by 50% (Tustiyani, 2017).

The use of coconut water in plant propagation is used to stimulate the formation of shoots and roots because it contains the hormones auxin and cytokinin (Febrianto et al., 2019). A coconut water concentration of 60% results in the fastest emergence time for red dragon fruit plant cuttings on average 3.58 days (Silawati and Syukri 2021). The use of plant growth regulator (PGR) will be effective at certain concentrations; If the concentration used is too high, it will damage the cuttings because cell division and callus will be excessive, thereby inhibiting the growth of flowers and roots, whereas if the concentration used is below optimum, the natural PGR will be ineffective. Therefore, this research aims to determine the effect of giving natural PGR to various sources of cutting material on the growth of chaya plants (Cnidoscolus aconitifolius).

BAHAN DAN METODE

This research was carried out in experimental garden at Sriwijaya University, Inderalaya, South Sumatera start from September to December 2022. This research was used factorial randomized block design two factors. The first factor is plant growth regulators (PGR) i.e., control, onion extract and coconut extract. The second factor is cutting stem i.e., top, middle, bottom stem. The cutting stem materials were taken from chaya plant which age 12 months old with each cutting measuring 20 cm. The natural PGR used are shallot extract and coconut water with a concentration of 100%. Onion extract is made using 1 kg of blended onions. Meanwhile, coconut extract is taken from 1 liter of coconut water 100%. The planting medium used is ultisol soil mixed with cow manure.

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RESULT AND DISCUSSION

Growth of bottom stem showed slightly better growth, it can be seen from plant height and number of leaves in 4th and 10th week. Meanwhile, there was no significant difference on growth, chaya plants originating from the top stem showed higher growth. According to (Lesmana et al., 2018) the use of cuttings originating from the middle stem and lower stem independently has the best effect on leaf area, number of leaves, and leaf dry weight. Interestingly, plant growth regulator (PGR) has no significant effect on growth chaya plant. In fact, control treatment of PGR showed higher growth and yield than onion and coconut extract (Figure 1).

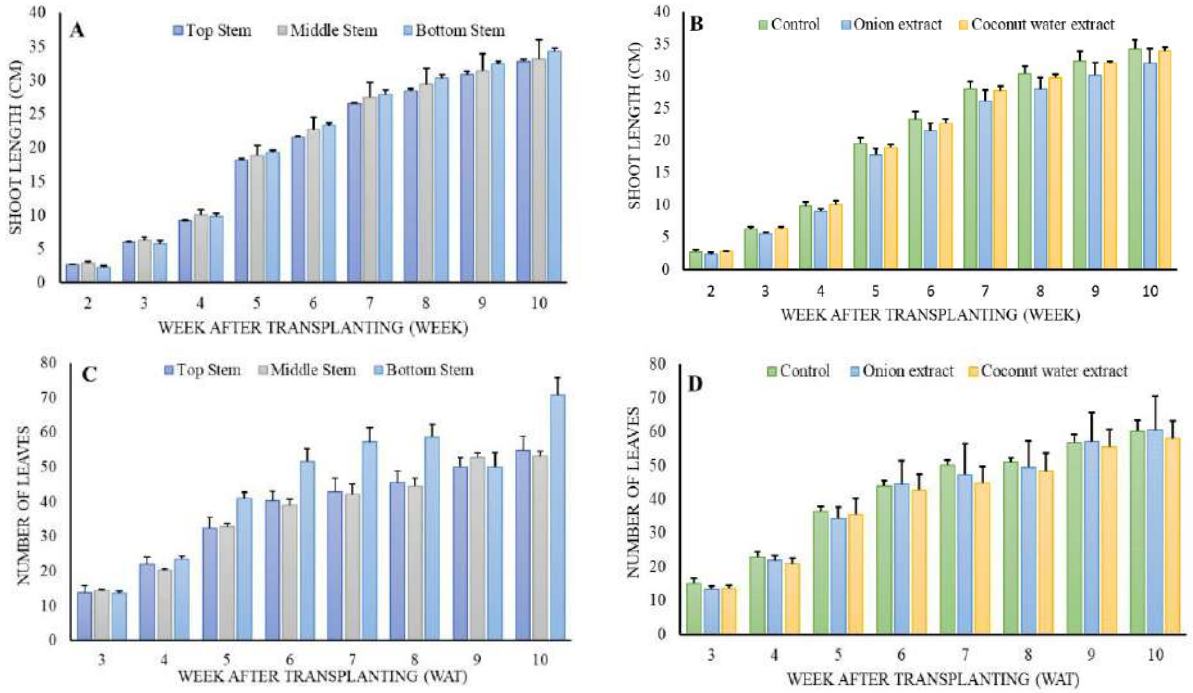

Figure 1. Shoot length and number of leaves in chaya plant affected by cutting stem (A-C) and extract growth inhibitors (B-D)

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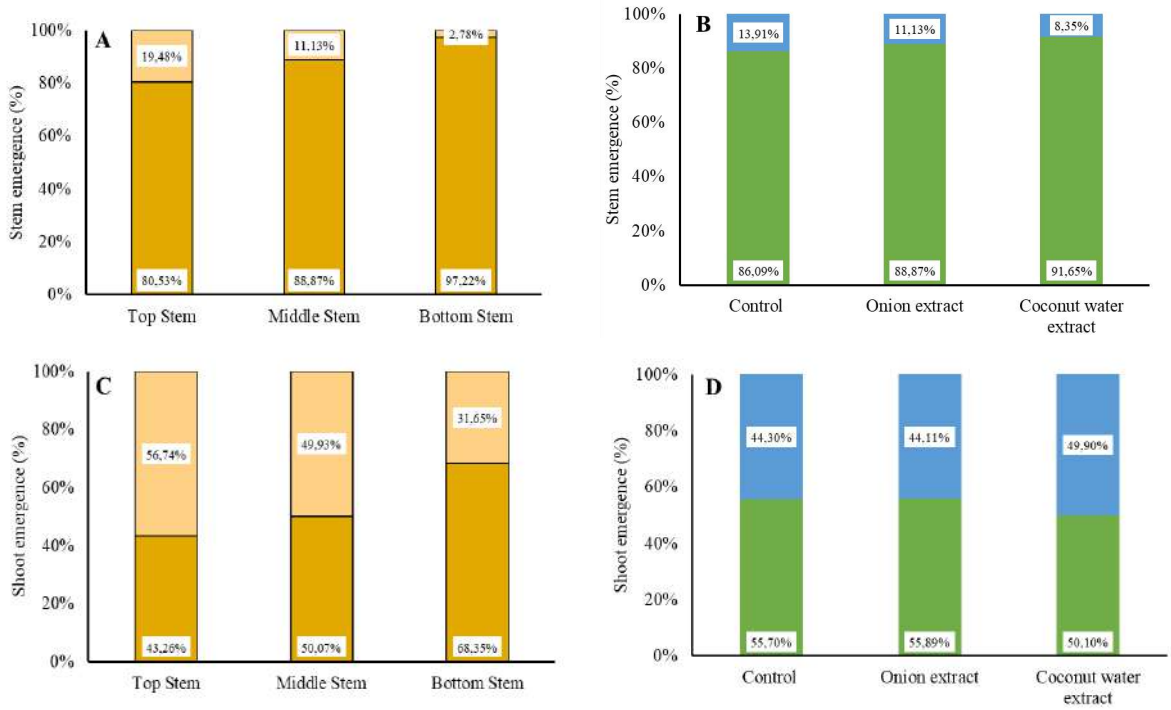


Figure 2. Stem and shoot emergence affected by stem cutting (A and C) and growing regulatory substances (B and D) in chaya plants

Cutting stem and PGR did not have a significant effect on the SPAD value (Figure 3). Gustiar et al (2023b) reported that there was no significant difference in the SPAD value of chaya plants. The SPAD value continuously increased from day 32 to 56. This shows that the SPAD of chaya plants consistently increased over the 6 days. So, it can be the basis for the right fertilization time for chaya plants.

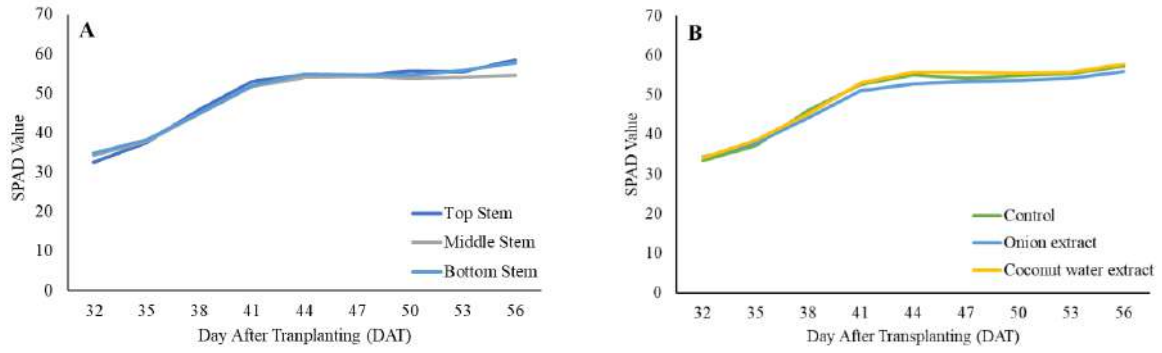


Figure 3. SPAD value on chaya plant affected by cutting stem (A) and extract growing regulatory substances (B) in chaya plants

Observations of leaf elongation and widening were carried out by measuring two samples of the same leaf continuously for up to 14 days. From the two samples measured, the chaya plants were shown to elongate and widen until they reached their maximum size on the 12th day. Furthermore, on days 13 and 14 there was no significant increase. This is the basis for the knowledge that chaya plant leaves can be harvested starting on the 12th day after the leaves fully open (Figure 4).

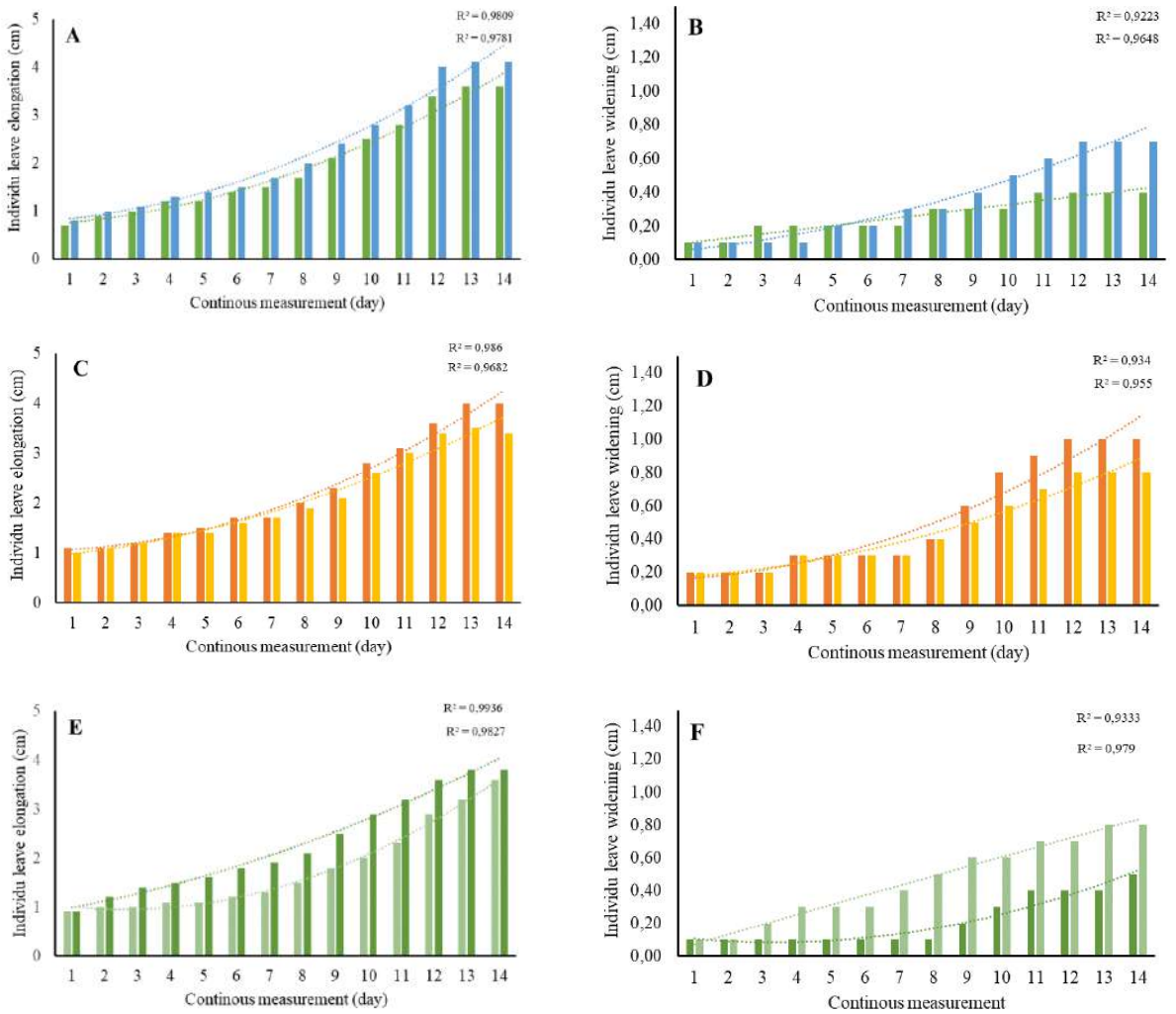
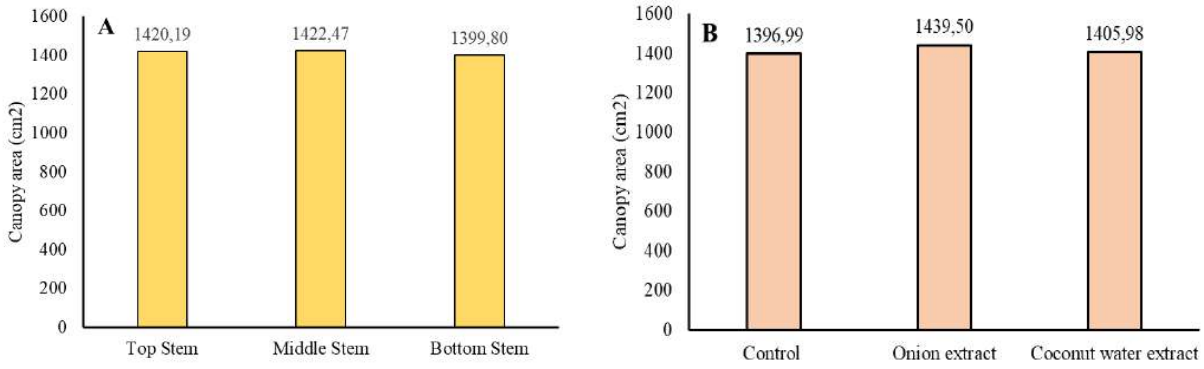


Figure 4. Individual leave elongation and widening affected by cutting stem i.e., top stem, middle stem, bottom stem (A, C, E), and extract growing regulatory substances i.e., control, extract onion, extract coconut water (B, D, F) in chaya plant

There was no significant difference between canopy area and shoot diameter in both the cutting stem and ZPT extract treatments (Figure 5). The effect of cutting stem was not visible on the number of branches, but did not differ significantly on the number of shoots. Furthermore, onion extract stimulates branch growth so that it has a greater number of branches (Figure 6). This occurs allegedly because the auxin content is higher in cuttings taken from the middle part. The middle planting material is also good for planting cuttings or vegetative plant propagation because the stem in the middle is neither too young nor too old. In this part, apart from having sufficient food reserves, it also has active shoot growth points that enable plants to grow, the success rate is high (Suryanti et al., 2022). Wathan (2022) reported that growing patchouli cuttings of the Lhokseumawe variety using a concentration of shallot extract resulted in better plant growth.



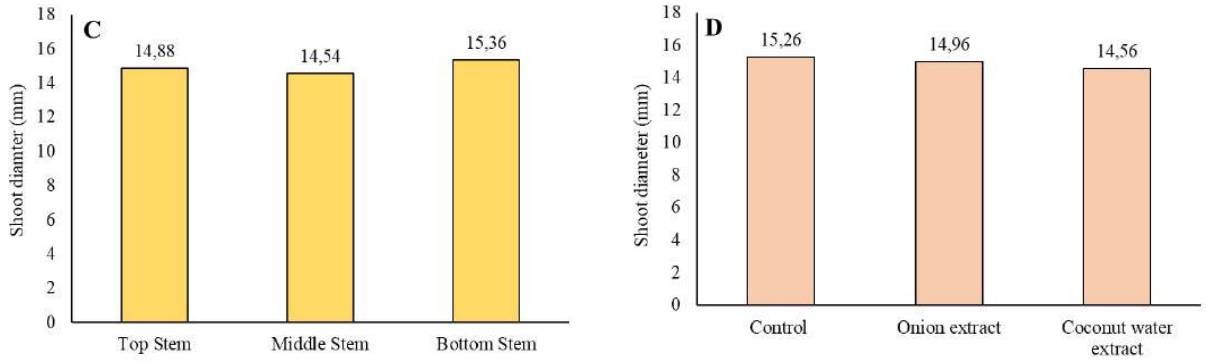


Figure 5. Shoot diameter affected by cutting stem (A-C) and extract growing regulatory substances (B-D) in Chaya plant

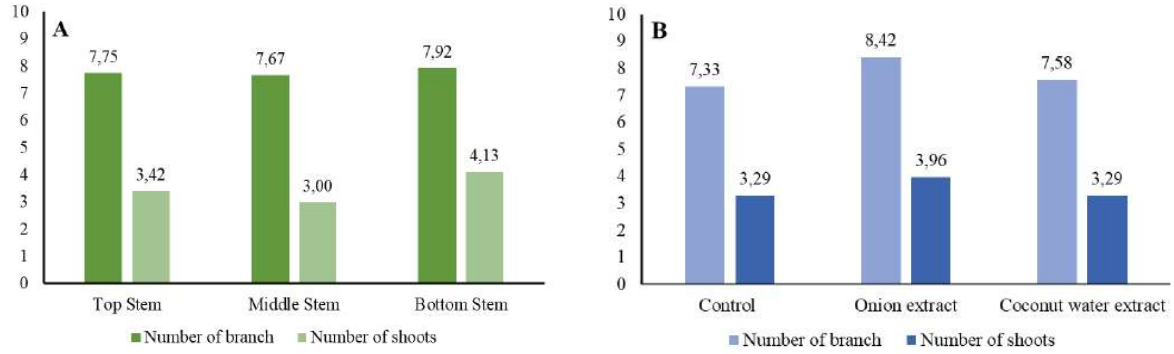


Figure 6. Number of branch and number of shoots on chaya plants affected by cutting stem (A) and extract growing regulatory substances (B).

Root formation is the main problem in propagation by cuttings, because the appearance of roots is an indication of whether the cutting was successful or not. The faster and more roots are formed, the greater the possibility of obtaining better results and being more resistant to unfavorable environmental conditions. The top stem has a longer root (Figure 7). Interestingly, Susilawati (2014) stated that stem cuttings from the bottom stem had the best effect on the number of roots, root length and dry weight of the roots.

Furthermore, giving onion extract also stimulates root growth, so that the chaya roots are longer. Good root growth will result in shoot growth as well (Figure 7). The auxin produced by onion extract influences the formation of root tissue in cuttings, while the formation of shoots is assisted by cytokinins. According to Martana et al. (2020), the right concentration of auxin in cells can increase osmotic pressure, increase cell permeability so that it can increase the diffusion of water and nutrients into the cells, so that by increasing the concentration of auxin in plants, it can activate root formation.

The ease of adventitious root formation is closely related to the concentration of natural PGR formed in the plant body, thus there is a close relationship between PGR and the ability of the cuttings to grow roots. The cutting material used, the growing environment and the treatment given to the cutting material are factors that influence shoot growth (Prastowo et al., 2006). Good cuttings are those that are able to produce balanced roots and shoots. The formation of cutting roots requires energy in the form of carbohydrates and proteins stored in the original planting material.

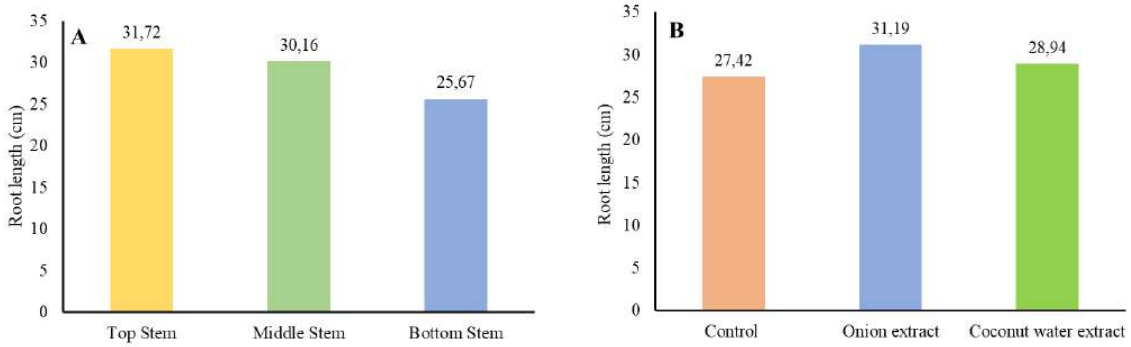
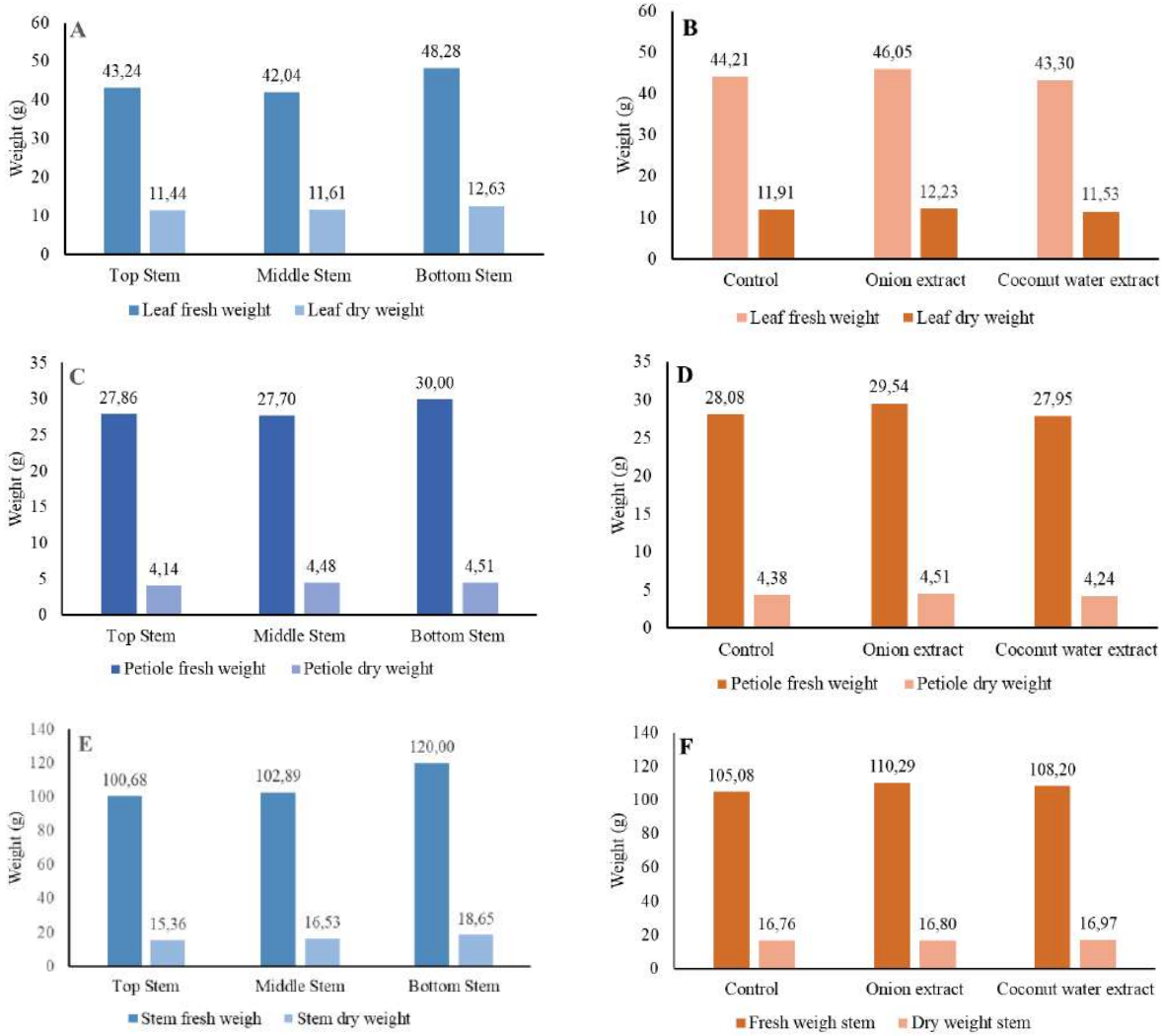


Figure 7. Root length of chaya plant affected by cutting stem (A) and extract growing regulatory substances (B).

Bottom stem produces fresh weight of leaves, petiole and stem higher than top and middle stem. However, interestingly, the bottom stem has a lower fresh root weight. It indicated that the roots of plants planted using bottom stem planting material have slower root growth than top and middle ones. Furthermore, although there were no significant differences between PGR extract treatments. However, onion extract showed a higher fresh weight than control and coconut water extract (Figure 8).



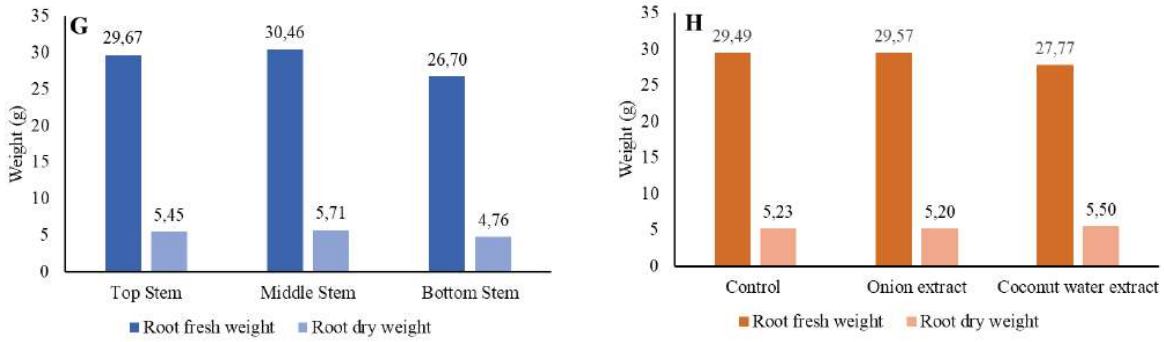


Figure 8. Fresh and dry weight on leaf, petiole, stem and root chaya plants affected by cutting stem (A, C, E, and G) and extract growing regulatory substances (B, D, F, and H).

The dry weight of the plant is the total weight of the plant after being dried in the oven, so that the water content has been lost and what remains are only the chemical compounds contained in the plant. According to Affrilah et al (2020) plant biomass indicates the number of chemical compounds contained in the plant, the higher the biomass, the more chemical compounds it contains, thereby increasing the dry weight of the plant. Plant dry weight is closely related to three processes, namely the fertilization process of assimilate through photosynthesis, a decrease in assimilate through the respiration process and a decrease in assimilate due to accumulation in storage.

Auxin in onion extract will increase the content of organic and inorganic substances in cells. Next, these substances will be converted into proteins, nucleic acids, polysaccharides and other complex molecules. These compounds will form tissues and organs, so that the wet weight of the seeds will increase. Auxin plays a role in cell elongation. This cell elongation mainly occurs in the vertical direction. This elongation will be followed by cell enlargement and increased wet weight. The increase in wet weight is mainly due to increased water uptake by the cells. Saidi (2018) reports that better plant roots will increase the growth and development of plant parts such as shoots, stems and leaves which will then increase photosynthetic activity.

CONCLUSION

Chaya plants propagated using bottom stem planting material showed the best growth and results including number of leaves, fresh weight of leaves. The optimal time to harvest chaya leaves is 12 days after the leaves fully open. Onion extract can increase the percentage of shoot and stem emergence, increase the number of branches, number of leaves, fresh leaf weight and root length.

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Matrik Revisi

Matrix of responses

Review	Revised
Add the influence of PGR extract on the abstract	Has been revised in the abstract
Please add reference about chaya plant	Reference about chaya plant has been added in the text
What are the ways to propagate it?	propagation of chaya plants through grafting and, cuttings
add references to the benefits of PGPR on other cutting plants	Has been revised
When	The research was conducted start from September to December 2022, has been revised in method.
Add the type of soil used	Has been revised
Please add reference effect of PGR on growth chaya plant	Has been revised
A more detailed explanation regarding the effect of ZPT on chaya plant cuttings	Has been revised
Figure 3 is not mentioned in the results	Has been revised
provide a more complete explanation regarding the effect of shallots on chaya plants	Has been revised

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The Effect of Cutting Stem and Plant Growth Regulator (PGR) on Chaya Plant

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ABSTRACT

Chaya (Cnidoscolus aconitifolius) Var. Picuda is an indigenous vegetable plant that is woody, drought resistant, and is generally propagated through vegetative propagation. Growth regulators greatly influence the growth of chaya plant cuttings. This research aims to determine the effect of giving natural plant growth regulator (PGR) to various sources of cutting material on the growth of chaya plants. This study used a two-factor randomized block design. The first factor is cutting stem i.e., top, middle and bottom stem and the second factor is growth regulators i.e. control, onion extract and coconut water extract. The research results showed that shallot extract had a positive influence on the emergence of shoots on chaya cuttings. Furthermore, the lower cutting planting material is either used as planting material for cuttings or for vegetative plant propagation. The bottom stem has sufficient food reserves and has an active bud growth point allowing the plant to grow and have a high growth success rate. The addition of onion extract can increase shoot and stem emergence, number of leaves, fresh weight of leaves.

Keywords: *Auxin; Chaya; Indigenous; Onion extract*

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INTRODUCTION

The chaya plant or what is often known as Japanese papaya is native plant from Yucatan peninsula of Mexico. Chaya is considered a neglected and underutilized crop owing to limited general knowledge about it, its poor representation in ex situ collections, and the lack of conservation programs (Munguía-Rosas et al., 2019). Chaya is a semi woody tree, drought tolerant and not require regular watering and other maintenance (Sudartini et al., 2020). Chaya plants are generally propagated vegetatively i.e., grafting, cuttings and grafting. The stem cutting materials used include top, middle, and bottom stem (Gustiar et al., 2023a). However, the acceleration in growth is different because the auxin content contained in each part of the plant is different. The most auxin is found at the top of the plant. The further down or further from the top of the plant the auxin content decreases. Increasing the success of cutting stems can be done by using plant growth regulators (PGR) (Ramadan et al., 2016). Natural growth regulators that can be used are onion extract (*Allium cepa* L) and coconut water (*Cocos nucifera*). Onion extract contain hormone auxin which can stimulate root growth in plant cuttings.

Onions contain the hormone auxin which can stimulate root growth in plant stems. In addition, in crushed onion the compound allithiamin will be formed. This compound can function to facilitate metabolism in plant tissues and can act as a fungicide and bactericide (Sofwan, 2018). Based on research results, shallot extract can increase the percentage of living coffee plant cuttings by 50% (Tustiyani, 2017).

The use of coconut water in plant propagation is used to stimulate the formation of shoots and roots because it contains the hormones auxin and cytokinin (Febrianto et al., 2019). A coconut water concentration of 60% results in the fastest emergence time for red dragon fruit plant cuttings on average 3.58 days (Silawati and Syukri 2021). The use of plant growth regulator (PGR) will be effective at certain concentrations; If the concentration used is too high, it will damage the cuttings because cell division and callus will be excessive, thereby inhibiting the growth of flowers and roots, whereas if the concentration used is below optimum, the natural PGR will be ineffective. Therefore, this research aims to determine the effect of giving natural PGR to various sources of cutting material on the growth of chaya plants (Cnidoscolus aconitifolius).

MATERIALS AND METHOD

This research was carried out in experimental garden at Sriwijaya University, Inderalaya, South Sumatera start from September to December 2022. This research was used factorial randomized block design two factors. The first factor is plant growth regulators (PGR) i.e., control, onion extract and coconut extract. The second factor is cutting stem i.e., top, middle, bottom stem. The cutting stem materials were taken from chaya plant which age 12 months old with each cutting measuring 20 cm. The natural PGR used are shallot extract and coconut water with a concentration of 100%. Onion extract is made using 1 kg of blended onions. Meanwhile, coconut extract is taken from 1 liter of coconut water 100%. The planting medium used is ultisol soil mixed with cow

manure.

The percentage of shoot and stem emergence was calculated at week 4th. The leaves chlorophyl was measured using a SPAD meter every 3 days start from 32 days after planting. Dry weight accumulation was measured after the plant biomass oven-dried at 70 ºC for 48 hours.

Data analysis was used Microsoft excel and analysis of variance method with F table. If F hit > F table with a probability of F that is greater than 1%, then it is concluded that the treatment factor has a very significant effect, denoted by (**). If F hit > F table at a probability of F that is greater than 5%, then it is concluded that the treatment factor has a real effect, denoted by (*). If F hit < F Table, it means that the treatment factor has no significant effect, denoted by ns. The further test procedure used to determine the differences between treatments is the Least Significant Difference (LSL) test at a test level of 5%.

RESULT AND DISCUSSION

Growth of bottom stem showed slightly better growth, it can be seen from plant height and number of leaves in 4th and 10th week. Meanwhile, there was no significant difference on growth, chaya plants originating from the top stem showed higher growth. According to (Lesmana et al., 2018) the use of cuttings originating from the middle stem and lower stem independently has the best effect on leaf area, number of leaves, and leaf dry weight. Interestingly, plant growth regulator (PGR) has no significant effect on growth chaya plant. In fact, control treatment of PGR showed higher growth and yield than onion and coconut extract (Figure 1).

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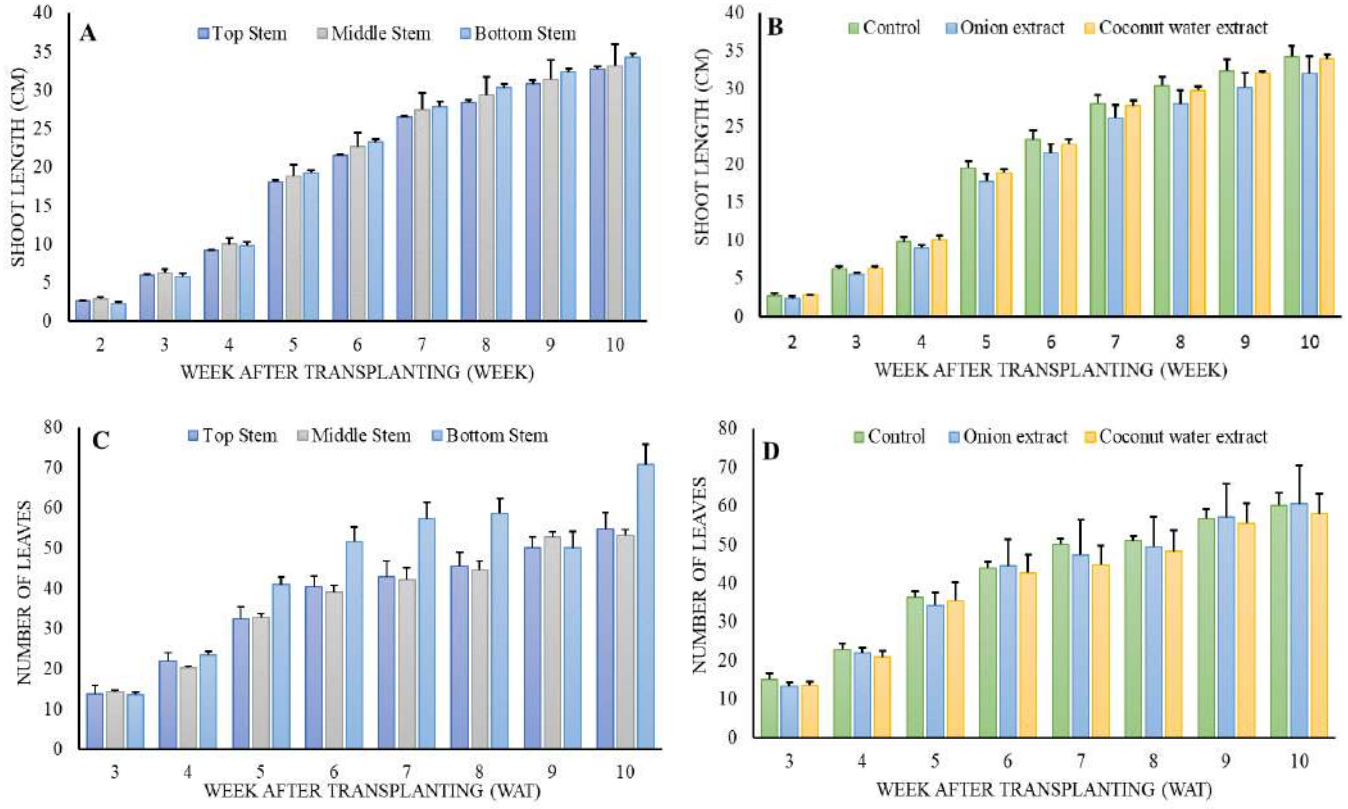
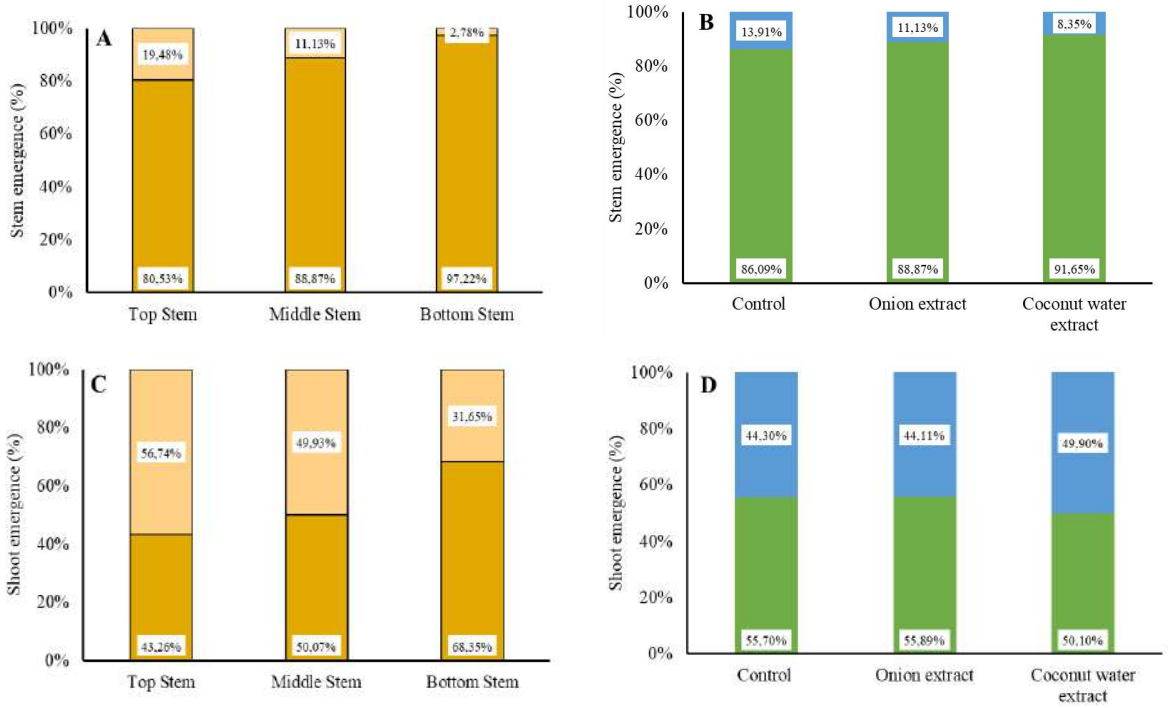


Figure 1. Shoot length and number of leaves in chaya plant affected by cutting stem (A-C) and extract growth inhibitors (B-D)



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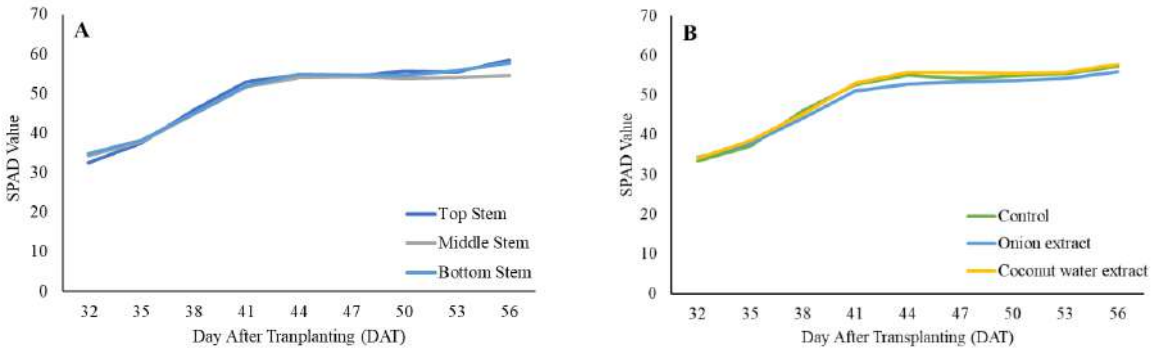

Figure 3. SPAD value on chaya plant affected by cutting stem (A) and extract growing regulatory substances (B) in chaya plants

Observations of leaf elongation and widening were carried out by measuring two samples of the same leaf continuously for up to 14 days. From the two samples measured, the chaya plants were shown to elongate and widen until they reached their maximum size on the 12th day. Furthermore, on days 13 and 14 there was no significant increase. This is the basis for the knowledge that chaya plant leaves can be harvested starting on the 12th day after the leaves fully open (Figure 4).

There was no significant difference between canopy area and shoot diameter in both the cutting stem and ZPT extract treatments (Figure 5). The effect of cutting stem was not visible on the number of branches, but did not differ significantly on the number of shoots. Furthermore, onion extract stimulates branch growth so that it has a greater number of branches (Figure 6). This occurs allegedly because the auxin content is higher in cuttings taken from the middle part. The middle planting material is also good for planting cuttings or vegetative plant propagation because the stem in the middle is neither too young nor too old. In this part, apart from having sufficient food reserves, it also has active shoot growth points that enable plants to grow, the success rate is high (Suryanti et al., 2022). Wathan (2022) reported that growing patchouli cuttings of the Lhokseumawe variety using a concentration of shallot extract resulted in better plant growth.

Root formation is the main problem in propagation by cuttings, because the appearance of roots is an indication of whether the cutting was successful or not. The faster and more roots are formed, the greater the possibility of obtaining better results and being more resistant to unfavorable environmental conditions. The top stem has a longer root (Figure 7). Interestingly, Susilawati (2014) stated that stem cuttings from the bottom stem had the best effect on the number of roots, root length and dry weight of the roots.

Furthermore, giving onion extract also stimulates root growth, so that the chaya roots are longer. Good root growth will result in shoot growth as well (Figure 7). The auxin produced by onion extract influences the formation of root tissue in cuttings, while the formation of shoots is assisted by cytokinins. According to Martana et al. (2020), the right concentration of auxin in cells can

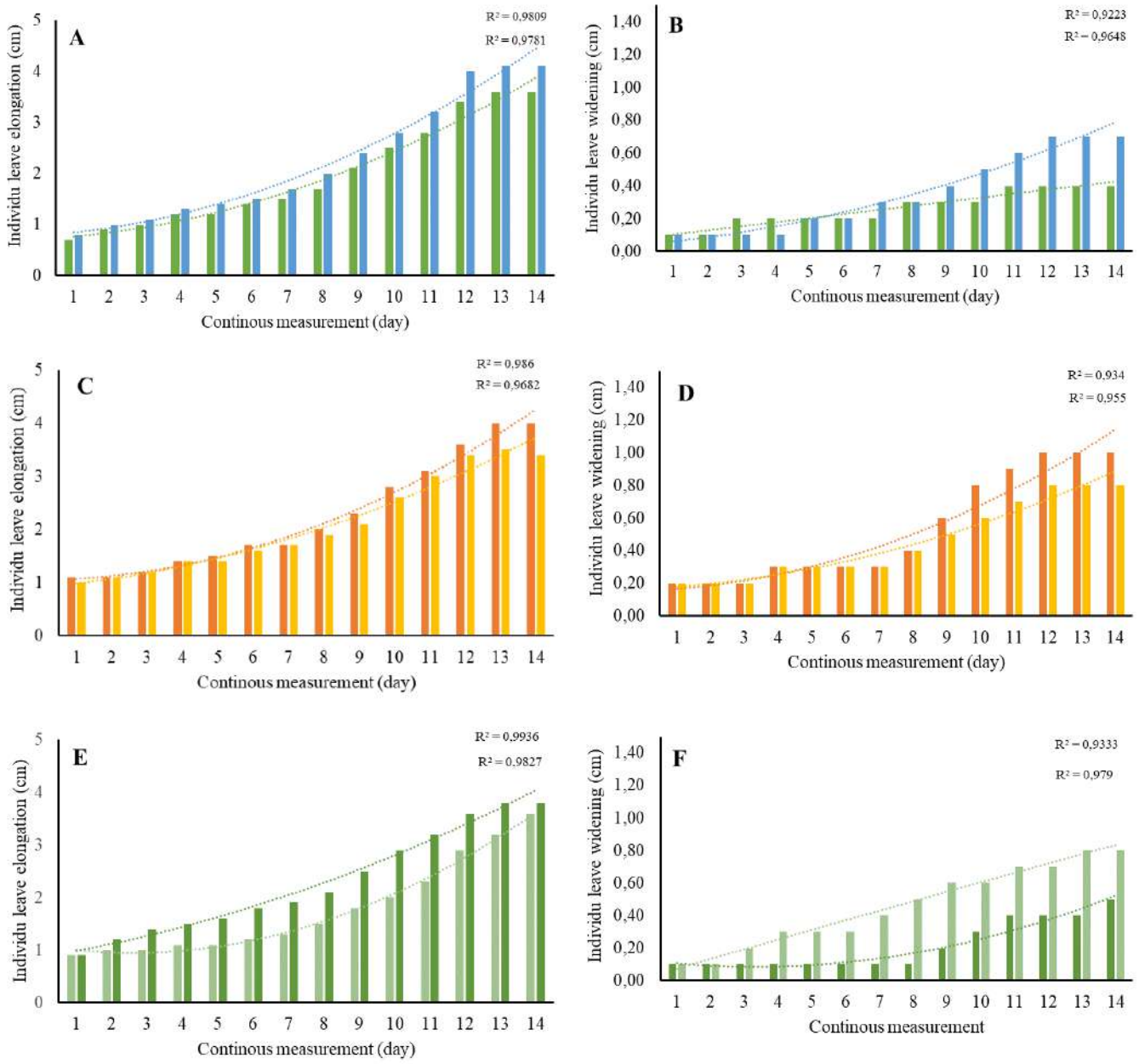

Figure 4. Individual leave elongation and widening affected by cutting stem i.e., top stem, middle stem, bottom stem (A, C, E), and extract growing regulatory substances i.e., control, extract onion, extract coconut water (B, D, F) in chaya plant

increase osmotic pressure, increase cell permeability so that it can increase the diffusion of water and nutrients into the cells, so that by increasing the concentration of auxin in plants, it can activate root formation.

The ease of adventitious root formation is closely related to the concentration of natural PGR formed in the plant body, thus there is a close relationship between PGR and the ability of the cuttings to grow roots. The cutting material used, the growing environment and the treatment given to the cutting material are factors that influence shoot growth (Prastowo et al., 2006). Good cuttings are those that are able to produce balanced roots and shoots. The formation of cutting roots requires energy in the form of carbohydrates and proteins stored in the original planting material.

Bottom stem produces fresh weight of leaves, petiole and stem higher than top and middle stem. However, interestingly, the bottom stem has a lower fresh root weight. It indicated that the roots of plants planted using bottom stem planting material have slower root growth than top and middle ones. Furthermore, although there were no significant differences between PGR extract treatments. However, onion extract showed a higher fresh weight than control and coconut water extract (Figure 8).

The dry weight of the plant is the total weight of the plant after being dried in the oven, so that the water content has been lost and what remains are only the chemical compounds contained in the plant. According to Affrilah et al (2020) plant biomass indicates the number of chemical compounds contained in the plant, the higher the biomass, the more chemical compounds it contains, thereby increasing the dry weight of the plant. Plant dry weight is closely related to three processes, namely the fertilization process of assimilate through photosynthesis, a decrease in assimilate through the respiration process and a decrease in assimilate due to accumulation in storage.

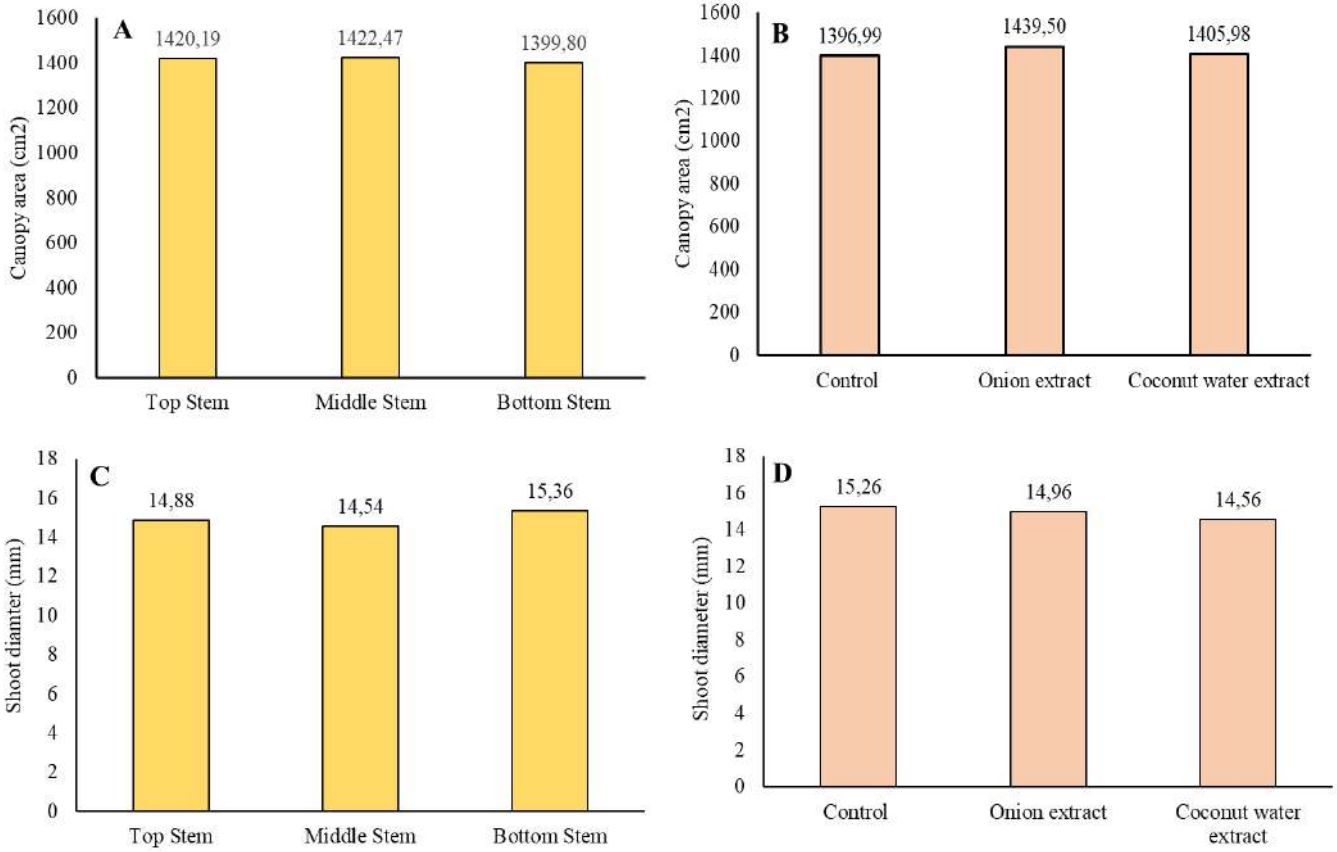

Figure 5. Shoot diameter affected by cutting stem (A-C) and extract growing regulatory substances (B-D) in Chaya plant

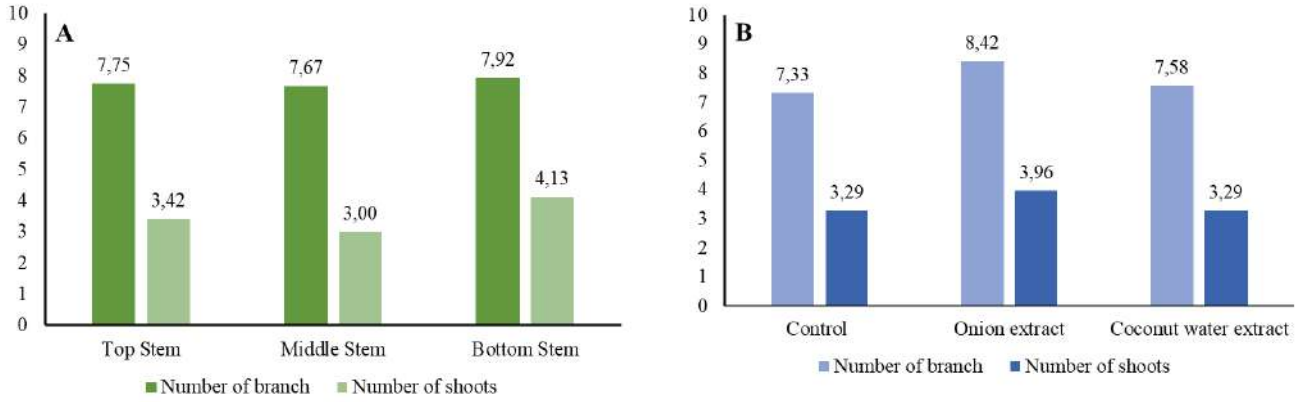

Figure 6. Number of branch and number of shoots on chaya plants affected by cutting stem (A) and extract growing regulatory substances (B)

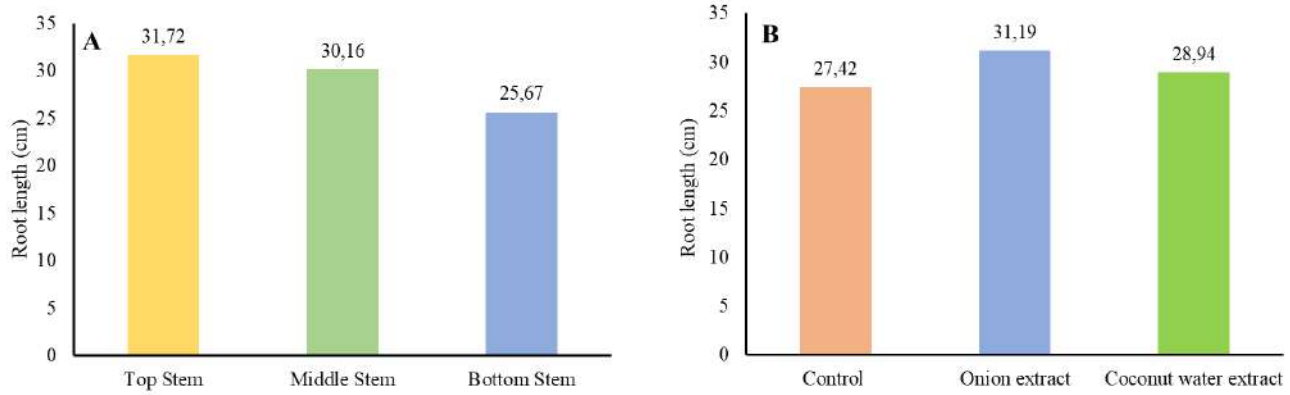

Figure 7. Root length of chaya plant affected by cutting stem (A) and extract growing regulatory substances (B)

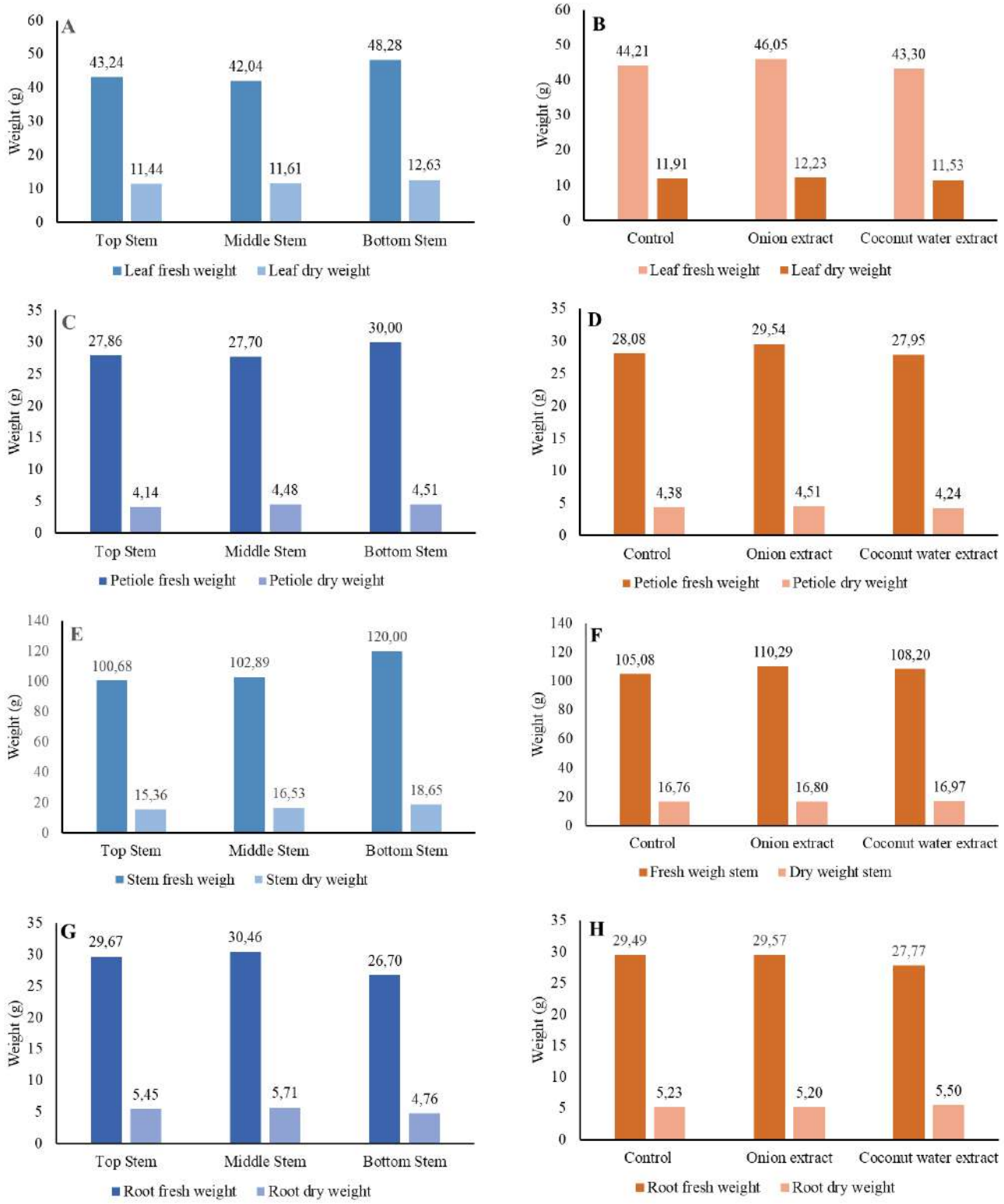

Figure 8. Fresh and dry weight on leaf, petiole, stem and root chaya plants affected by cutting stem (A, C, E, and G) and extract growing regulatory substances (B, D, F, and H).

Auxin in onion extract will increase the content of organic and inorganic substances in cells. Next, these substances will be converted into proteins, nucleic acids, polysaccharides and other complex molecules. These compounds will form tissues and organs, so that the wet weight of the seeds will increase. Auxin plays a role in cell elongation. This cell elongation mainly occurs in the vertical direction. This elongation will be followed by cell enlargement and increased wet weight. The increase in wet weight is mainly due to increased water uptake by the cells. Saidi (2018) reports that better plant roots will increase the growth and development of plant parts such as shoots, stems and leaves which will then increase photosynthetic activity.

CONCLUSION

Chaya plants propagated using bottom stem planting material showed the best growth and results including number of leaves, fresh weight of leaves. The optimal time to harvest chaya leaves is 12 days after the leaves fully open. Onion extract can increase the percentage of shoot and stem emergence, increase the number of branches, number of leaves, fresh leaf weight and root length.

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