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RESEARCH ARTICLE

THE POTENTIAL OF BANANA STEM AS PLANTING MEDIA FOR KANGKUNGS (*Ipomoea reptans* Poir) AND MUSTARD GREENS

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ABSTRACT

Banana stem water content is 90%. Therefore, it is potential as an alternative for planting media in limited agriculture lands due to their function changes. The aim of the research is to obtain information on cultivation technology and how long water content in banana stem is available for plant. This research employed the randomized block design- split plot with two treatment factors. The first factor was banana stem durations after harvest (0, 2, and four weeks) and the second one was vegetable crops, namely: kangkungs and mustard greens. Based on the treatment level, there were six combinations, and each was replicated 4 times. The research variables were height, number of leaves, chlorophyll content, nitrogen tissue, leaf area index, specific leaf area, unit price of leaves, growth rate, biomass (dry weight of the plant), length of root, and fresh weight of the plant. The result of the research shows that all treatments applied to banana stems had no effect on all variables tested. Banana stems could provide water to *Ipomoea reptans* Poir for the duration of 37 days after planting, and to mustards greens for the duration of 32 days after planting. Above the stated duration, the plant died due to water excess. Thus, banana stems had the potential to provide water for plants from planting to harvest, and the plants planted did not require additional watering.

Keywords: growth, leaf, stem, vegetable, water

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INTRODUCTION

The farmland and yard are getting narrower on one hand, and the population continues to increase on the other hand, which causes the food demand als to increase continuously. Various planting media technologies have been widely developed in agro-forestry (Budiastuti & Purnomo, 2012) peatland (Darmawan, Siregar, Sukendi, & Zahrah, 2016), swamp (Harun, 2012; Waluyo, 2014), dryland, and hydroponics (Sesanti, 2016). Banana stems contain water up to 90% so that they are potential as growing media either for nursery or cultivation media.

In addition to the moisture content, the banana stems contain low carbohydrate (Rismunandar, 1989). In detail, the water, protein, and carbohydrate contents are 92.5%, 0.35%, and 4.4% respectively. In some treatments, the planting media added with compost from banana stems can improve soil structure so that it can improve the growth of seedlings such as Jabon seedlings.

Planting media of banana stem has a limited planting area, only 7 cm in diameter. Therefore, it is only potential for small plants such as kangkungs and mustard greens. Kangkungs have the advantages of dry resistance, wide adaptation of various environments, easy to maintain, and fast harvest (Suratman, Priyanto, & Setyawan,

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2000). Mustard greens have sprout of fibers that grow and spread, and their fiber roots are short, only 5 cm. Mustard greens' roots can grow and develop on loose soil, fertile, and easy to absorb water (Cahyono, 2003). The short roots allow the mustard greens to be planted on the banana stem media. The objectives of this research are to investigate how long banana stems provide water for kangkungs and mustard greens and to determine their responses when planted in banana stems.

MATERIAL AND METHODS

This experimental research was conducted in Kebakkramat, Karanganyar from June to August 2016 with the geographic position of North latitude: 7 ° 31 '16' and of East longitude: 110 ° 54 "27' and with the elevation of 98 m above sea level. The research used the split plot group randomized design with two treatment factors. The first factor was the stem of banana from varieties Awak (main plot) consisting of fresh banana stems of 0, 2, and 4 weeks after the cutting (wac). The second factor is kind of vegetable plants (subplot) that is kangkungs (varieties Serimpi) and mustard greens (varieties Tosakan). Based on the extent or kinds of treatments, there were 6 combinations, each repeated four times.

The implementation of research was initiated with vegetable seed soaking in warm water to speed germination. Holes were made in the growing media with the diameter of 7 cm, the depth of 8 cm, the total lanes of 2, and the spacing of 10 x 10 cm. Soils mixed manures as organic fertilizers were then put into the holes. The seeds of kangkungs and greens mustard were planted in the media as many as 2 seeds per hole. Then, at the age of 7 days, only one plant was left alive. Plant husbandry, among others, included control of pests and diseases (manually) and removal of weeds growing around the area of cultivated plants.

Observations were carried out destructively from the beginning to the constant growth at the age of 10, 20, 30, and 40 days after transplanting (DAT). The observations included those of plant height (measured using a ruler, from the base of the stem to the stem end), the number of leaves (counted every 10 days), the fresh weight of the plants (using digital scale with the capacity of 200g), length of roots (measured by using a ruler from the base of the root to the tip of the root), biomass plant (weighing the plant after having been exposed to the oven treatment of 80 ° C until its weight was constant), leaf area (using the gravimetric method), the levels of chlorophyll (using a spectrophotometer at the age of 30 days), nitrogen tissue (using Kjedhal method at the age of 30 days), leaf area index, specific leaf area, unit price of leaves, and the growth rate. The data of the research were analyzed by using the F test = 0.05, when the results were significant, they were then exposed to the Duncan's multiple range test of 0.05.

RESULT AND DISCUSSIONS

Character of Banana Stems

Fresh banana stems had the water content of 97%. Two weeks and four weeks after having been felled, their water contents were 96% and 94.33% respectively. Therefore, the water required during the research did not become an obstacle. In areas with limited water, banana stems can be used as a growing media during the dry season, because the water content is very high, about 92.5% (Rismunandar, 1989). Previous studies did not examine how long the water content lasted in the banana stems after having been felled. The relatively high response of plants to water content in a banana tree would appear in the growth of kangkungs and mustard greens. The availability of water in the banana stems is likely long lasting, but if the stems then decay

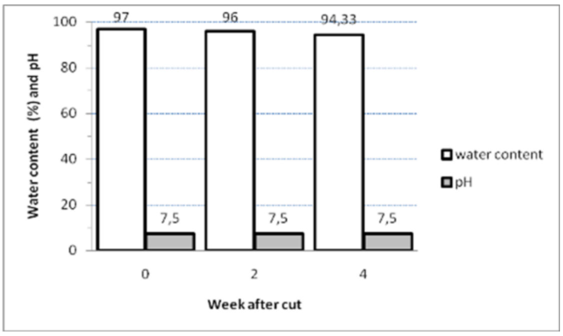

Figure 1. Water Content and pH in Banana Stems in Early Planting

so that they are mushy, plants will collapse. The role of water in banana stems as a buffer appears in a soil pH of 7.5 at media can be said to be neutral (Figure 1).

Plant Height

Kangkungs transplanted on the fresh banana stem media could grow well. Their height continued to increase from 10 to 30 DAT from 5.50 cm to 29.63 cm in the final time of trial. Based on the weekly data, at the beginning of growth (ages 0-20 DAT) every 10 days their height increased by 11 cm. On 20 to 30 DAT their height increased by 13 cm. However, at the end of the growth (40 DAT) their height was constant. The growth of kangkungs best took place in the banana stem media aged 0 WAF from 10 to 30 DAT in which the height increased to 29.63 cm. The height of mustard greens also increased from 10 to 20 DAT from of 5.13 cm to 6.88 cm in the fresh banana stem media. During the early growth (ages 0-10 DAT), their height increased by 5.13 cm. On 20 DAT, they reached the peak of growth, reaching the height of 6.54 cm. On 30 DAT, their height remained constant, while over 30 DAT, their growth was constant, and even many of them died. Banana stem as growing media either fresh or 0 week, 2 weeks, and 4 weeks after having been felled (WAF) did not have any effect on height of kangkungs and mustard greens (Table 1).

Based on theory, the plant growth is divided into three phases: slow growth, fast growth, and constant growth. Plant growth is slow at first, and it is then gradually faster until it reaches the point of maximum, and finally its growth rate decreases (Taiz, Zeiger, Møller, & Murphy, 2015). The growth pattern is fast at the vegetative phase to a certain extent due to the increase of the plant cells, and the growth then slows and even becomes constant. The plant growth for all crops more or less is fixed, but deviations may occur as a result of environmental variation. The final size, appearance, and shape of plants are determined by a combination of genetic factors and environmental influences (Sitompul, 2016; Sitompul & Guritno, 1995).

Number of Leaves

The number of *kangkungs* leaves transplanted in the fresh banana stem media rose steadily from 10 to 30 DAT from 3 pieces into 7 pieces. During early growth (age 0-20 DAT) every 10 days the number of leaves

Table 1. Analysis of Variance of Plant Height on 30 DAT

Source	df	sum of square	means square	F_{count}	Sig.
Block	3	53.365	17.788	.468	.716
Age of stem	2	68.771	34.385	.904	$.454^{ns}$
Galat of age of stem	6	127.729	21.288	.560	.751
Types of plants	1	2.370.094	2.370.094	62.320	.000**
Age of stem * types of plants	2	83.312	41.656	1.095	$.393^{ns}$
Galat of types of plants	3	73.781	24.594	.647	.613
Total	23	3.005.240			

Remarks: ns (not significant), * (significant), ** (very significant) increased 2 pieces. At age 20 to 30 DAT the leaf number increased by one piece, while at the end of growth 40 DAT even the leaf number reduced due to yellowing and falling. Similarly, the number of leaves in mustard greens also increased from 10 to 20 DAT from 3 pieces to 4 pieces of leaves during experiment on fresh banana stems media. In the initial stages of growth (0-10 DAT) three new leaves grew. 30 DAT was the peak of growth, with the leaves spotted amounting to 4 sheets. After 30 DAT, no increase in number of leaves was spotted, even many plants of mustard greens died. The growing media of banana stems aged 0, 2, and 4 WAF did not affect the number of leaves in *kangkungs* and mustard greens. Plant death after the age of 30 days is due to its inability to survive in the relatively saturated media. Stagnant water is a major abiotic stress that determines the success or failure of crops based on the frequency and wide puddle (Visser, Voesenek, Vertapetian, & Jackson, 2003).

Chlorophyll Content

Chlorophyll as a chloroplast component plays a significant role in photosynthesis. The chlorophyll rate can be used as a benchmark in determining the availability of N in media which is then absorbed by the plants. The highest rate of chlorophyll a on *kangkungs* was 12.14 µg per grams of fresh leaves on treatment of banana stems aged 4 WAF, while on mustard greens, the highest rate was 13.73 µg per grams of fresh leaves on treatment of banana stems aged 2 WAF. The highest rate of chlorophyll b on *kangkungs* was 4.97 µg per grams of fresh leaves on treatment of banana stems aged 4 WAF, while on mustard greens was 5.83 µg per grams of fresh leaves on treatment of banana stems aged 2 WAF. Thus, the rates of chlorophyll a and chlorophyll b on *kangkungs* were lower than those on mustard greens.

In this research, it was found that the rate of chlorophyll a was higher than that of chlorophyll b, both on *kangkungs* and mustard greens. Normally, the rate of chlorophyll a is significantly lower than that of chlorophyll b. Plants under full intensity of light are found to have a minimum content of chlorophyll, which applies to both chlorophyll a and b (Ermawati, 1990). On the contrary, in a shaded condition, infrared light will work, which in turn encourages the production of chlorophyll a (Salisbury & Ross, 1995). In the research conducted by (Sri Wahyudyana Hurip Pradnyawan, Widya Mudyantini, & Marsusi, 2005), it also was shown that 70% of shade would cause in the increase of chlorophyll a in the leaves of *Gynura procumbens* (Lour) Merr. Meanwhile, in the plants which were not shaded, the content of chlorophyll a in their leaves was lower than those in the other treatment. The chlorophyll amount in plants is affected by some factors, namely: the genetic factor of plants, the intensity of light, oxygen, carbohydrate, nutrients, water, and temperature (Dwidjoseputro, 1980).

The highest amount of carotenoids in *kangkungs* was found in those planted on banana stems aged 4 WAF, amounting to 581.68 µg g^{-1}. Meanwhile, in mustard greens, the highest amount of carotenoids was found in those planted on banana stems aged 2 WAF, amounting to 631.56 µg g^{-1}. (Novizan, 2001) opined that the availability of nutrients, especially nitrogen plays a role in the forming of chlorophyll which is useful to photosynthesis, since nitrogen is a constituent of chlorophyll. The growing media of banana stems aged 0, 2, and 4 WAF did not directly affect the amount of carotenoids in *Kangkungs* mustard greens aged 30 DAT.

Tissue Nitrogen Content

Nitrogen (N), in general, is the main limiting factor in the production of biomass of plants. On average, the biomass of plants contains 1-2% of nitrogen. (Gardner, Pearce, & Mitchell, 1991). The tissue nitrogen content of

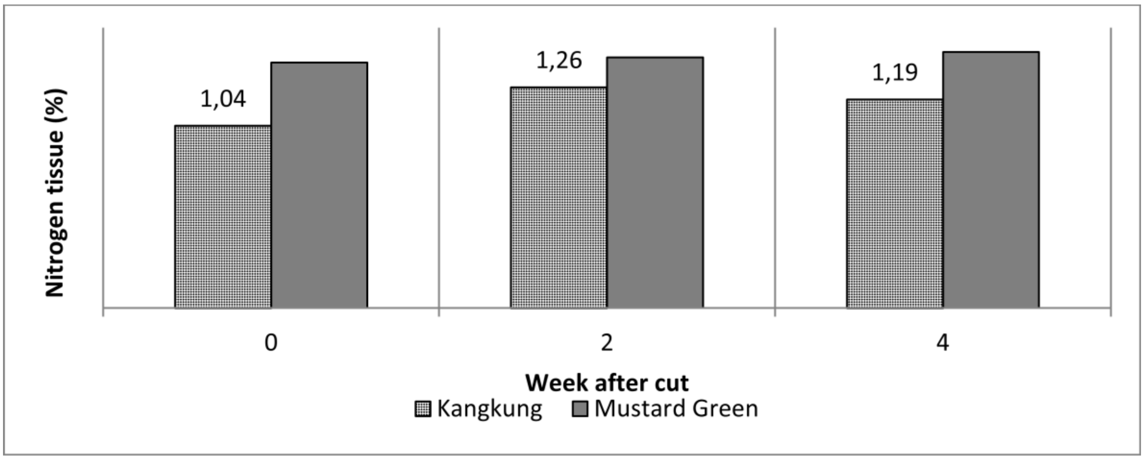

Figure 2. Tissue Nitrogen Content in Plants at 30 DAT

kangkungs had no apparent difference in all variables of banana stems. The highest level of tissue nitrogen content in *kangkungs* was found on the treatment of growing media of banana stems aged 2 WAF, amounting to 1.26% (Figure 4). The growing media of banana stems aged 0, 2, and 4 WAF did not affect the tissue nitrogen content in *kangkungs* aged 30 DAT.

Correspondingly, the tissue nitrogen content in mustard greens was not much different on all treatments. The highest tissue nitrogen content was found on the treatment of growing media of banana stems aged 4 WAF, which was 1.46% (Figure 2). The growing media of banana stems aged 0, 2, and 4 WAF did not affect the tissue nitrogen content in mustard greens aged 30 WAF. In this research, the level of tissue nitrogen content in *kangkungs* and mustard greens is considered as standard. In principle, nitrogen is needed in plants for protein synthesis, either structural or enzymatic synthesis. The enzymes are responsible for all kinds of synthesis process, whether it is protein, fat, pigment, or other cell structure components. These compounds later on will compose the body of the plant and are needed for cell and organ growth, including the production of the biomass of plant. (Lawlor, Lemaire, & Gastal, 2001).

Leaf Area Index

Based on the number of leaves, it was found that the leaf area was increased. The leaf area index (LAI) was calculated by comparing the leaf area of plant canopy to the area of soil where the plant grows. The LAI calculations conducted in this research was an assumptive approach, since the plants were not planted on a stretch of land. The LAI in *kangkungs* increased from 10 to 30 DAT, from 0.03 to 0.05 at the end of experiment in banana stems aged 4 WAF. In the initial stages of growth (day 0-20 after planting) no increase of LAI was spotted for every 10 days. On > 20 to 30 DAT, the LAI increased by 0.01 points, while in the final stage of growing, or 40 DAT, no increase in leaf area was spotted.

Likewise, the LAI in mustard greens also increased from 10 to 30 DAT, from 0.04 points to 0.09 points during experiment on the media of banana stem aged 4 WAF. Based on weekly data, in the initial stages of growth (day 0-10 after planting) the LAI of plantsb increased by 0.04 points. 30 DAT was the peak of growth, with the LAI level was 0.09 points. Following 30 DAT, no increase in growth was spotted, even many plants of mustard greens died. The growing media of banana stems aged 0, 2, and 4 WAF did not affect the LAI in *kangkungs* and mustard greens.

The LAI of the two plants were considered very low. The ideal LAI is 5 points (Sitompul, 2016). Thus, the plant growth is under optimum condition. This can be explained sufficiently as the result of the non-optimum leaf formation, which was reflected by the number of leaves, and the very low fresh weight.

Specific Leaf Area

The specific leaf area is determined by dividing the leaf area to the leaf mass. The index contains information of leaf thickness, which can reflect the photosynthesis organelle unit. The specific leaf area of *kangkungs* was decreasing on 10 to 30 DAT, from 306.96 cm^2 g^{-1} to 22.43 cm^2 g^{-1} at the end of experiment on the growing media of banana stems aged 0 WAF.

Based on weekly data, in the initial stages of growth (0-20 DAT) the specific leaf area decreased every 10 days. On 20 to 30 DAT, the specific leaf area decreased by 16 cm^2 g^{-1}, while in the final stage of growing, 40 DAT, there was no increase in specific leaf area.

The specific leaf area in mustard greens also decreased since 10 to 30 DAT, from 994.05 cm^2 g^{-1} to 145.24 cm^2 g^{-1} during experiment on banana stem media aged 4 WAF. Based on weekly data, in the initial stages of growth (day 0-10 after planting) the specific leaf area was decreased 250 cm^2 g^{-1}. 30 DAT was the day when the lowest specific leaf area was spotted, with the area of 97.62 cm^2 g^{-1} on treatment of banana stems aged 2 WAF. After 30 DAT, no increase or decrease in specific leaf area was spotted, even many plants of mustard greens died. The specific leaf area value was decreased, which indicates that the leaves were getting thicker. (Sutoro, Dewi, & Setyowati, 2008). Based on the observation result, every 10 days the specific leaf area of *kangkungs* and mustard greens was decreasing, which means that the leaves were getting thicker until the end of experiment. The growing media of banana stems, either freshly cut, aged 0, 2, or 4 WAF did not affect the specific leaf area in *kangkungs* and mustard greens.

Leaf Unit Price

Leaf unit price is the ability of each leaf in producing biomass from photosynthesis result. *Kangkungs* had the highest absolute growth rate on the treatment of growing media of banana stems aged 2 WAF, amounting to 0.05 g cm^{-2}. The leaf unit value for all treatments of mustard greens had the same value of 0.01 g cm^{-2}. The growing media of banana stems aged 0, 2, and 4 WAF did not directly affect the absolute growth rate in mustard greens aged 30 DAT.

The leaf unit price is influenced by leaf characteristics related to photosynthetic process, covering interception, conversion of sun radiation or light, and the absorption and reduction of CO_2. All these characteristics can change as the plants get older, or because of the environmental difference or plant treatment. (Sitompul & Guritno, 1995). Light determines photosynthetic process through organelles which organize photosynthesis. Chlorophyll and ribulose bisphosphate carboxylase/oxygenase (RuBisCO) are the most important molecules in photosynthetic process. Nitrogen is one of the elements which play a role in the synthesis of the two molecules. The increasing absorption of nitrogen will result in the increasing content of nitrogen in leaves. The tissue nitrogen content in leaves will stimulate the improvement of the plant metabolic rate. (Salisbury & Ross, 1995).

Growth Rate

Kangkungs had the highest absolute growth rate on the treatment of growing media of banana stems aged 2 WAF, amounting to 5 mg/day. The growing media of banana stems aged 0, 2, and 4 WAF did not directly affect the absolute growth rate in *kangkungs*. Absolute growth rate is biomass production per unit of time which is considered to be constant. *Kangkungs* had the highest relative growth rate on the treatment of growing media of banana stems aged 0 WAF, amounting to 7 mg/day. The growing media of banana stems aged 0, 2, and 4 WAF did not directly affect the relative growth rate in *kangkungs* aged 30 DAT.

The growth rate is aimed to investigate the ability of plants to produce dry material as the result of assimilation per unit of area per unit of time. The highest absolute growth rate in mustard greens was found on the treatment of growing media of banana stems aged 4 WAF, amounting to 0.4 mg/day. The growing media of banana stems aged 0, 2, and 4 WAF did not directly affect the absolute growth rate in mustard greens. Mustard greens had the highest relative growth rate on the treatment of growing media of banana stems aged 0 WAF, amounting to 14 mg/day. The growing media of banana stems aged 0, 2, and 4 WAF did not directly affect the relative growth rate in mustard greens aged 30 DAT.

Plant Biomass

Plant biomass is considered as the manifestation of all processes and occurrences happening in the growth of plants. It is the indicator of plant growth. Biomass itself causes weight gain, followed by other growths at the same time. *Kangkungs* grew well. The biomass of plant increased since day 10 until 30 DAT, from 0.02 g to 0.15 g at the end of experiment on fresh banana stem media. Based on weekly data, in the initial stages of growth (0-20 DAT), the biomass increased by 0.05 g everyday. On >20 to 30 DAT, the biomass increased by 0.06 g, while at the end of growing (day 40 after planting) no increase in biomass was spotted. (Table 2).

The biomass of mustard greens also increased on 10 to 20 DAT, from 0.01 g to 0.02 g during experiment on fresh banana stems media. Based on weekly data, in the initial stages of growth (0-10 DAT), the biomass increased by 0.01 g. On 30 DAT, the plant attained peak of growth, with the biomass of 0.09 g, while after 30 DAT, no signs of growing appeared, even many plants died. The growing media of banana stems aged 0, 2, and 4 WAF did not affect the biomass of *kangkungs* and mustard greens. There are some factors affecting the toleration of plants to waterlogging, namely variety, plant growth phase, and the duration of waterlogging. (Boru, Vantoai, Alves, Hua, & Knee, 2003).

Plant biomass is influenced by sunlight and nitrogen. The obstacle encountered in cultivation in the yard is the denseness of canopy, which causes the intensity of light obtained by the plants to be low. The sun radiation elements which are important to plants are intensity of light, quality of light, and the duration of irradiation. If the intensity obtained is low, then the amount of light obtained by each area of leaf surface in a

Table 2. Analysis of Variance of Plant Biomass on 30 DAT

Source	df	sum of square	means square	F_{count}	Sig.
Block	3	.004	.001	1.120	.412
Age of stem	2	.001	.000	.408	.682^{ns}
Galat of age of stem	6	.016	.003	2.325	.164
Types of plants	1	.026	.026	22.722	.003*
Age of stem * types of plants	2	.004	.002	1.587	.280^{ns}
Galad of types of plants	3	.005	.002	1.411	.328
Total	23	.062			

Remarks: ns (not significant), * (significant), ** (very significant) given time period is low. (Gardner et al., 1991). The lack of light further results in disorder of metabolism, thus lowering the rate of photosynthesis and carbohydrate synthesis. (Djukri & Purwoko, 2003). The high intensity of light will increase the level of carotenoids, nitrogen content, and influence the anatomical structure of leaf (Salisbury & Ross, 1995), making the leaf surface to be more opened. However, a very high intensity of light will decrease the chlorophyll content of leaves.

Nitrogen is an essential element of plant constituent compound which determines the quality of organic materials in plants. Nitrogen is found on various compounds of plant protein, nucleic acids, hormones, chlorophylls, and some primary and secondary metabolites. Nitrogen is also essential for cell division, cell enlargement, and growth. (Anggarwulan & Solichatun, 2001; Gardner et al., 1991).

The length of roots in *Kangkungs* increased since the start of growing to 20 DAT, from 5.13 cm to 6.63 cm at the end of experiment on fresh banana stems media. Based on weekly data, in the initial stages of growth (0-20 DAT), the length of roots increased 1 cm every 10 days. On >20 to 30 DAT, the length of roots constantly increased, while at the final stage of growth on day 40 DAT, no increase on the root length was found.

Similarly, the length of roots in mustard greens also increased from 20 to 30 DAT, from 1.38 cm to 4.88 cm during experiment on growing media of banana stems aged 4 WAF. Based on weekly data, in the initial stages of growth (day 0-10 after planting), the root length increased 1 cm. On 30 DAT, peak of growth was achieved, amounting to 4.88 cm. The growing media of banana stems aged 0, 2, and 4 WAF did not affect the length of roots in *Kangkungs* and mustard greens.

Fresh Weight of the Plant

Kangkungs grew well. The fresh weight of the plant was steadily increasing from 10 to 30 DAT, from 0.48 g to 1.99 g at the end of experiment. Mustard greens also experienced an increase in the fresh weight, from 10 to 20 DAT, from 0.14 g to 0.34 g at the end of experiment. The two conditions were spotted in plants planted on fresh banana stems. The average fresh weight of *Kangkungs* was 1.62 g/plants, while the average fresh weight of mustard greens was 0.73 g/plants. Such weights are considered low (the standard fresh weight of *Kangkungs* is 480 g/plant, while for mustard greens is 800 g/plant) at the maximum growth on 30 DAT.

The yield was low because the soil was in a water-saturated condition from the start of growing to harvest. The rooting of plants was sunk to soil with high humidity, which was derived from water in banana stems. Ever-wet soil is not good for plant growth. The root is faced to the condition of low availability of oxygen and high rate of CO_2. According to (Shimamura, Mochizuki, Nada, & Fukuyama, 2002), there are two possibilities of inundated plants: first, only the roots are inundated; second, all parts of plants are inundated. The symptoms of waterlogging obstruct the lengthening of stems, thus obstructing the overall growth of plants.

(David, 2001) suggested that water should be used if necessary particularly when plants need water for production and when the soil is dry to the depth of 15 cm. This was strengthened by a research conducted by (Jafar, Thomas, Kalangi, & Lasut, 2013), proving that the frequency of watering on the seedlings of *Anthocephalus macrophyllus (Roxb.) Havil.* affects the quality of growth. The watering for 2 times a day (300 cc) in plants aged 3-5 months improved growth. It was apparent from height, diameter, number of leaves, and the dry weight of crown. The watering for 3 times a day, on the contrary, decreased plant growth.

In this research, the growing media of banana stems provided an abundant water supply, and tended to be excessive, so it inhibited growth, such as fresh weight and leaf area. The low fresh weight of plants resulted in low biomass. The small leaf area resulted in small leaf area index and specific leaf area.

Kangkungs and mustard greens were cultivated in banana stem media. The banana stem felled and then used for transplanting media had high water content. The high water content in banana stem caused rooting of plants to submerge, resulting in less optimal growth. The low growth of length of roots caused general growth to be low. Small leaf caused leaf area index and specific leaf area to be low. Of the overall variables, information was obtained that low fresh weight will cause low plant biomass and small leaf area.

CONCLUSION

1. Banana stems were capable of providing water from planting to harvest to kangkungs (*Ipomoea reptans l. Poir*) and mustards greens. The former experienced the optimum growth until 37 days after planting and the latter experienced the optimum growth until 32 days after planting. After the stated duration, the plants died.
2. Banana stems had a great potential to provide water to plants from planting to harvest, and the plants did not require additional watering

RECOMMENDATION

1. In places where water is difficult to obtain, banana stems can be used as growing media.
2. It is necessary to conduct study on modification of banana stems, related to the disposal of water excess if used as growing media.

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