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# Proceedings

## Internasional Seminar on Tropical Horticulture 2018: Horticulture for The Quality of Life

December 10, 2018
Bogor, Indonesia
IPB International Convention Center

Published by:
PKHT (Center for Tropical Horticulture Studies), IPB University
Bogor, April 2019

# PROCEEDINGS

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## *Horticulture for The Quality of Life*

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**Pusat Kajian Hortikultura Tropika LPPM – IPB**
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**Theme:**

Horticulture for The Quality of Life

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# FOREWORD

International Seminar on Tropical Horticulture 2018: Horticulture for The Quality of Life was held in IPB International Convention Center, Bogor, Indonesia, December 10, 2018. This seminar organized by Center for Tropical Horticulture Studies (PKHT), IPB University and supported by Center of Excellence in University (PUI-PT), Ministry of Research, Technology and Higher Education.

We’re very glad to know the fact that the seminar displayed a very wide discussion about tropical horticulture with delegates from 5 countries (Japan, Taiwan, Thailand, China, and Indonesia) as keynote speech and participants. 31 papers were selected to be included in this proceeding from 23 oral presentation and 38 poster presentation.

This proceeding is contained of three sub chapter, that is ornamental plants, fruits, and vegetables. There are 5 papers of ornamental plants, 8 papers of fruits chapter and 17 papers of vegetables chapter

We wish to thank Prof. Slamet Susanto, Prof. Sanesuki Kawabata, Prof. Masayoshi Shigyo, Prof. Sobit, Prof. Ming-Tsair Cahn, Mr. Rahmansyah Darmawan being keynote speech at this international seminar and all participants for very lively atmosphere during and after the seminar.

Bogor, July 2019

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Dr. Awang Maharijaya

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# Biomass Production and Quality of Orange Jessamine (*Murraya paniculata* [L.] Jack) Leaves at Two Harvest Interval

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## Abstract

Orange jessamine is a medicinal plant that has potential as an antioxidant and until now information on the cultivation and quality of its leaves active compound still limited. This research was conducted at Bogor Agricultural University experimental station (Indonesia), from April to October 2013. The objectives of this research was to study the effect of harvest interval on biomass production and bioactive content. The experiment was laid out in a completely randomized block design with single factor, i.e. 5 and 12 weeks harvest interval, with three replications. Data were analyzed using t student test. Plants harvested every 12-weeks gives best yield and regrowth for orange jessamine. Protein content and PAL activity were increased in the next harvest, either at 5 or 12-weeks harvest interval. Plants harvested every 5-weeks for three harvests had no significantly different on phenol and flavonoid production with 12-weeks harvest interval for one harvest.

Keywords: flavonoid, harvest interval, Murraya paniculata, phenolic, phenylalanine ammonia-lyase (PAL)

## 1. Introduction

Orange jessamine (*Murraya paniculata* [L.] Jack) is a medicinal plant of the family Rutaceae, in effective oral doses is safe to use (Gautam *et al*., 2012a) and has the potential to reduce blood cholesterol levels (Pane, 2010), antiobesity (Iswantini *et al*., 2011), antidiabetic (Gautam *et al*, 2012b), antifertility (Xiao dan Wang, 1991), antidiarrheal (Rahman *et al*., 2010), anti-inflammatory and *antinociceptive* (Wu *et al*., 2010; Podder *et al*., 2011) and antioxidant (Gautam *et al*., 2012c; Paramaguru *et al*., 2012).

A plant has the potential the potential as an antioxidant characterized by the presence of polyphenols (Lugasi *et al*., 2003). Polyphenols are divided into two main groups namely phenolic and flavonoids, which create 1/3 to 2/3 of all antioxidants (Tapiero *et al*., 2002). The antioxidant effect of orange jessamine leaves might be due to the phenolic content of it leaves. Orange jessamine leaves contain steroids, saponins, flavonoids, tannins and alkaloids (Syahadat and Aziz, 2012). Flavonoids are part of poliphenols which are known to have properties as free radical scavenging, hydrolysis and oxidative enzyme inhibitors and work as anti-inflammatory (Pourmorad *et al*., 2006).

All phenolic compounds are produced from the phenylpropanoid pathway. Phenylalanine ammonia lyase (PAL) is an important enzyme in the production of phenolic compounds. The level of PAL activity depends on the genotype, age and development stage, organs, as well as plant tissue types (Camm and Towers, 1973). In addition, PAL activity is also influenced by various factors including light, temperature, growth regulators, RNA inhibitors, protein synthesis, wounding and nutrients (Jones, 1984).

Flavonoids are derivative products of the phenylpropanoid pathway. An important step in flavonoid biosynthesis is the condensation of malonyl CoA molecules with one molecule p-coumaroyl-CoA to C15 chalcone intermediate (naringenin chalcone), this reaction is catalyzed by chalcone synthase and subsequently transformed into various flavonoid products (Cheng *et al*., 2009). Anthocyanins are part of flavonoid compounds and have antioxidant effects to protect the heart (cardioprotective) (Ververidis *et al*., 2007).

Orange jessamine has been widely used, but information about crop cultivation is still limited, particularly harvest interval as it will determine the active ingredient in it. Proper harvest settings will be useful to get optimal results with maximum quality. The objective of this research was to study the effect of harvest intervals on biomass production and it bioactive content.

## 2. Materials and Method

The research was conducted from April to October 2013 in the Cikarawang IPB experimental garden, Dramaga, Bogor. The materials and tools used in this study include 18-month old orange jessamine, agricultural lime (85% $CaCO_3$), laying hen manure, rock phosphate, husk ash, Heraeus Labofuge-400R centrifuge, freeze dryer Flexy-DryTM MP, Waterbath Eyela SB-24, and Shimadzu UV-1800 spectrophotometer.

The study was conducted using a randomized block design of one treatment factor, namely the harvest interval. The harvest interval consists of two levels, namely 5 and 12 weeks. Each treatment consists of six plants. The experiment was carried out using plots with a size of 2 m x 1 m and a distance between plot 50 cm. Basic treatment in the form of agricultural lime and laying hen manure is given before planting seedlings in the field. Agricultural lime (2 ton/ha) is given by way of evenly distributed on land 4 weeks before planting (WBP). Laying hen manure (5 kg/planting hole) is given 1 WBP. Rock phosphate (0.45 kg) and rice-hull ash (2 kg) are given around the planting hole together at planting. Planting is done by transferring seedling from polybags to plots. The spacing used is 1 m with a depth of 30 cm. Flowers and fruits from generative phase were removed from seedlings.

Uniformity of plant height was carried out four weeks after planting at a height of 75 cm from the ground. Harvesting is done by cutting the plants at a cutting height of 75 cm. Harvesting at 5-week intervals is carried out at 9, 14 and 19 weeks after planting (WAP); while harvesting at 12-week intervals was carried out at 16 and 28 WAP (Table 1).

*Table 1. Harvest schedule of Orange Jessamine during the observation*

| Harvest intervals (weeks) | 4 | 9 | 14 | 16 | 19 | 28 |
|---|---|---|---|---|---|---|
| | …………WAP (weeks after planting)………… | | | | | |
| 5 | √* | √ | √ | | √ | |
| 12 | √* | | | √ | | √ |

Note: √ = harvest, * = harvest is not included in data processing.

The variables observed included biomass production, leaves quality, and secondary metabolite production. The biomass observed was leaves fresh weight, stem-branch fresh weight, total fresh weight (leaves weight + stem-branch weight), leaves dry weight, stem-branch dry weight, total dry weight (leaves dry weight + stem-branch dry). Leaves quality variables were observed in medium leaves (leaves after the fifth leaf from shoots), including: protein content (Lowry *et al*., 1951), PAL (Dangcham *et al*., 2008), phenolic content which calculated gallic acid equivalents (Waterhouse, 2002), flavonoid levels which calculated the quercetin equivalent (Chang *et al*., 2002). The production of secondary metabolites observed included phenolic production and flavonoid production. The production of secondary metabolites is calculated as a result of multiplication of leaves biomass with its levels. Changes in biomass, leaf quality and secondary metabolite production were observed at 9, 14 and 19 WAP at the 5-week harvest interval; and at 16 and 28 WAP at the harvest interval every 12-weeks.

The measurement data were analyzed using student t-test to determine the harvest interval which gave the best response to the observed variables.

## 3. Results and Discussion

Biomass production and bioactive content of orange jessamine are influenced by cultivation practices, including harvest intervals. Harvest intervals affect biomass production, nutritional value, and the ability to regrow plants afterward (Man and H Wiktorsson, 2003).

<u>Effect of harvest intervals on biomass production (g)</u>

The second harvest at both the five-week and 12-week harvest intervals gave a very significant increase in leaves fresh weight, stem fresh weight and total fresh weight compared to the first harvest (Figures 1a, 2a, and 3a), this was due to loss of apical dominance which stimulated branch formation, more lateral branches so that biomass production rises in the second harvest. However, in the third harvest at the five-week harvest interval, poor crop regrowth was characterized by decreased biomass of orange jessamine (Figures 1a, 2a, and 3a). Orange jessamine harvesting at the five-week harvest interval in three harvests gave a cumulative result that was not significantly different from the first harvest of the 12-week harvest interval on biomass production components including leaves fresh weight, stem fresh weight and total fresh weight (Figures 1a, 2a and 3a). Short harvest intervals cause the opportunity for plants to accumulate photosynthates to be shorter, while at longer leaves harvest intervals plants can grow longer to accumulate photosynthetic results so that plants can grow optimally.

This result was same with the previous experiment that the highest fresh and dry forage production of torbangun (*Coleus amboinicus*) plants was obtained at 60-day cutting intervals, followed by 40, 30-day cutting intervals and the lowest at 50-day cutting intervals (Sajimin *et al*., 2011).

The dry weight of plants reflects the accumulation of organic compounds that have been synthesized by plants from inorganic compounds, especially water and carbon-dioxide. The dry weight gain of plants is also a contribution of nutrients that have been absorbed by the roots. The dry weight of plants is a result of the efficiency of absorption and utilization of solar radiation available throughout the cropping period by plant canopy (Kastono *et al*., 2005). The dry weight of leaves, stem and branch dry weight, also total dry weight in the second harvest at the five-week and 12-week harvest intervals increased significantly compared to the first harvest, while leaves dry weight, stem-branch dry weight and total dry weight of orange jessamine in the third harvest at the five-week harvest interval decreased compared with results in the second harvest and not significantly different from dry weight in the first harvest (Figures 1b, 2b, and 3b).

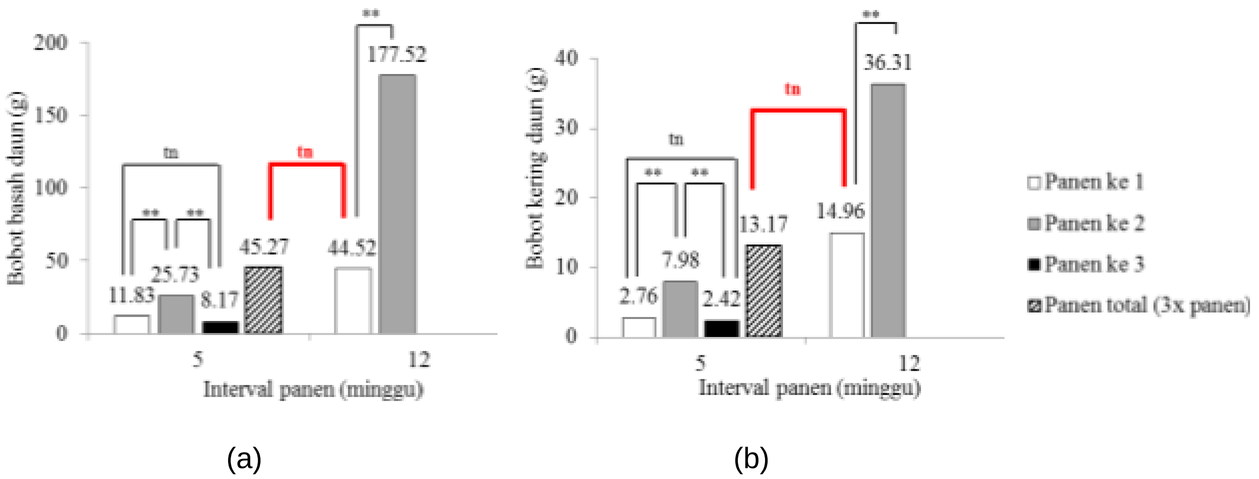



*Figure 1. Fresh (a) and dry leaves weight (b) of orange jessamine at 5 and 12-weeks harvest interval; **: significantly different at P ≤ 0.01, ns: not significant at P > 0.05.*

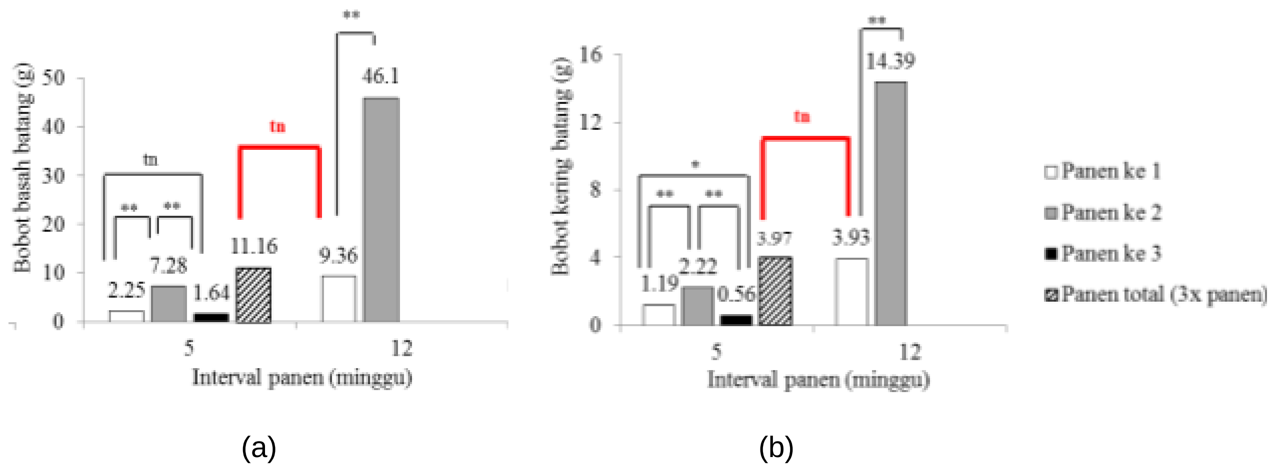
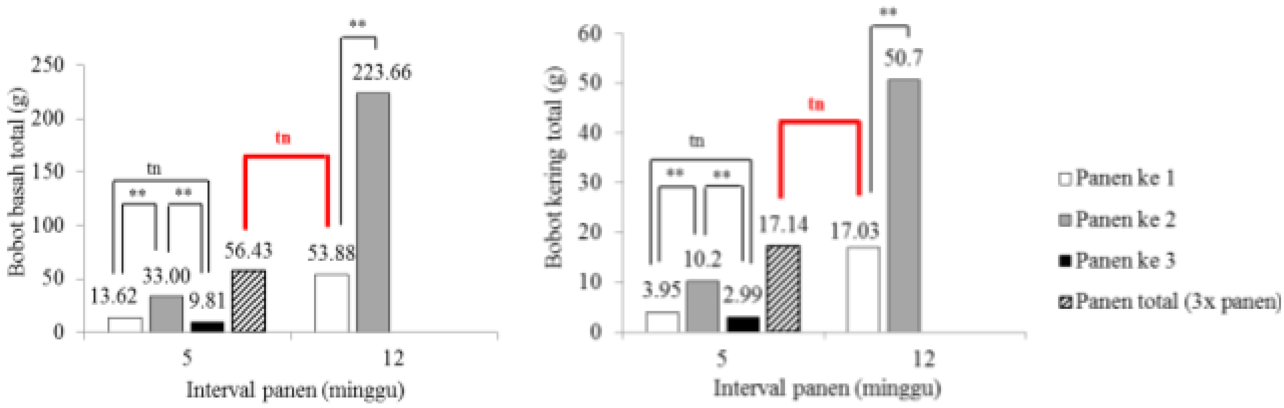



*Figure 2. Fresh (a) and dry stem weight (b) of orange jessamine at 5 and 12-weeks harvest interval; **: significantly different at P ≤ 0.01, ns: not significant at P > 0.05*




(a) (b)

*Figure 3. Total harvest fresh (a) and dry weight (b) of orange jessamine at 5 and 12-weeks harvest interval; **: significantly different at P ≤ 0.01, ns: not significant at P > 0.05.*

The cumulative results of leaves dry weight, stem-branch dry weight and total dry weight of orange jessamine at the 5-week harvest interval in three harvests were not significantly different from the 12-week harvest interval (Figures 1b, 2b, and 3b). The dry weight increases linearly with a delay in harvest frequency (Kabi and Lutakome, 2013). Dry weight of orange jessamine decreases with increasing harvest frequency, this is because plants need time for the recovery phase that affects the recovery of carbohydrate reserves and decreases the level of dry matter production (Erdmann *et al*., 1993).

The leaves dry weight to total dry weight proportion increased with increasing harvest frequency, while the proportion of stem-branch dry weight showed the opposite pattern. The percentage of leaves dry weight from the first harvest to the third harvest at the five-week harvest interval, respectively 69.87%, 78.24%, and 80.94%. Conversely, the percentage of stem-branch dry weight decreased in the next harvest at the five-week harvest interval, respectively 30.13%, 21.76% and 18.73%. The proportion of leaves dry weight in the 12-week harvest interval decreased from the first harvest to the second harvest, 87.84% and 71.62% respectively. Similar results also reported on cassava plants (Kang *et al*., 2005)

Determination of crop intervals that are too short can have adverse effects on plants and ultimately affect the results produced. The monthly harvesting intervals of *Leucania*, *Gliricidia* and *Sesbania* plants which can increase mortality by 25% (Duguma *et al*., 1988). Earlier leaves harvests and frequencies that more often reduce vegetative growth and yield of tuber seeds (*Xanthosoma sagittifolium*). This means that if the leaves are pruned earlier and more often, the strength of the source (leaves) decreases and causes photosynthate accumulation to the sink to decrease (Asumadu *et al*., 2011).

*<u>Protein levels, PAL activity, phenolic levels, and total levels flavonoids</u>*

Protein is a polymer composed of several amino acids and is involved in growth, photosynthesis and homeostasis. Protein content in leaves has increased in the next harvest cycle, both at the five and 12-week harvest intervals (Figure 4a). Protein levels are higher in *Desmanthus virgatus* plants which are more often harvested (Suksombat and Buakeeree, 2006). The results of other studies showing that leaves protein levels were influenced by harvest intervals also been reported in other plants (Amaglo *et al*., 2006; Susanti *et al*., 2011; Osadebe *et al*., 2014)

Levels of active ingredients of medicinal plants vary according to the stages of growth and development of plants and parts of the organs analyzed, this is related to the activity of enzymes during the metabolic process of these active ingredients. The PAL activity of orange jessamine leaves has a pattern similar to protein levels in the five and 12-week harvest intervals (Figure 4b). It is presumed that the initial response from the openings (such as pruning) caused de novo synthesis and increased PAL activity (Campos-Vargas *et al*., 2004). The treatment of the five-week harvest interval resulted in plants being gripped and causing an increase in PAL activity. This increase in PAL activity was not followed by an increase in flavonoid levels at the five-week harvest interval, while the increase in phenolic levels was not real. Phenolic levels in the first, second and third harvests were not significantly different at the five-week harvest interval, whereas at the twelve-week harvest interval the phenolic levels were significantly different between the first and second harvests (Figure 5a). Flavonoid levels at the five-week harvest interval had a pattern that was contrary to the levels of protein and PAL activity (Figures 4 and 5b). Flavonoid levels at the five-week harvest interval were highest in the first harvest cycle and decreased in the second and third harvest cycles, while at the twelve-week harvest interval flavonoid levels increased in the second harvest cycle. Decreased levels of flavonoids in the second harvest have also been reported in *Satureja hortensis, Majorana hortensis* and *Thymus vulgaris* (Vábková and Neugebauerová, 2011). This can be caused by other secondary metabolite products such as anthocyanins, and lignin which are synthesized during the change of phenolic compounds into flavonoid compounds. Therefore, the formation of flavonoids does not always depend on PAL activity (Cheng *et al*., 2012).

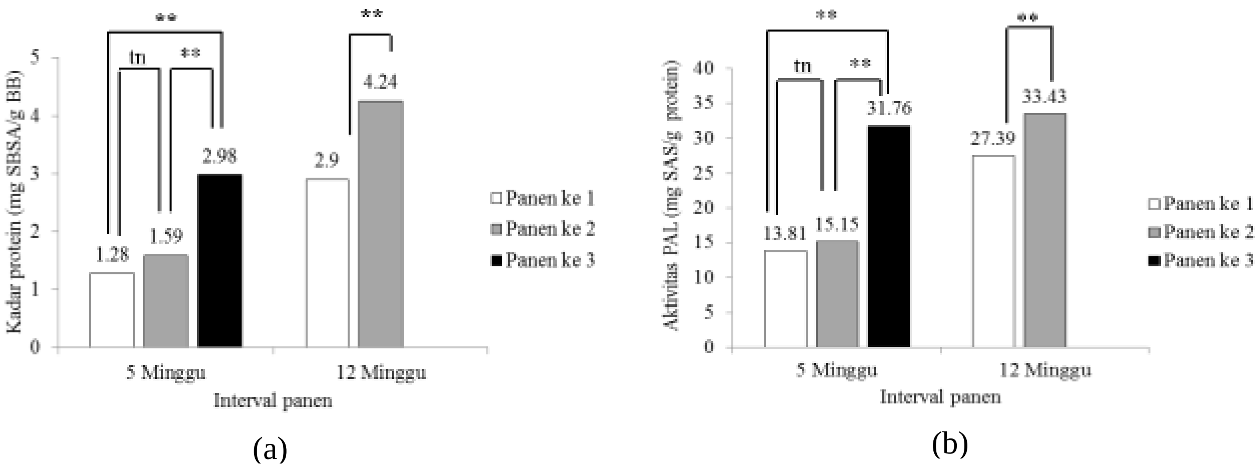



*Figure 4. Protein content (a) and PAL activity (b) of orange jessamine at 5 and 12-weeks harvest interval; BSAE: bovine serum albumin equivalent, CAE: cinnamic acid equivalent, **: significantly different*

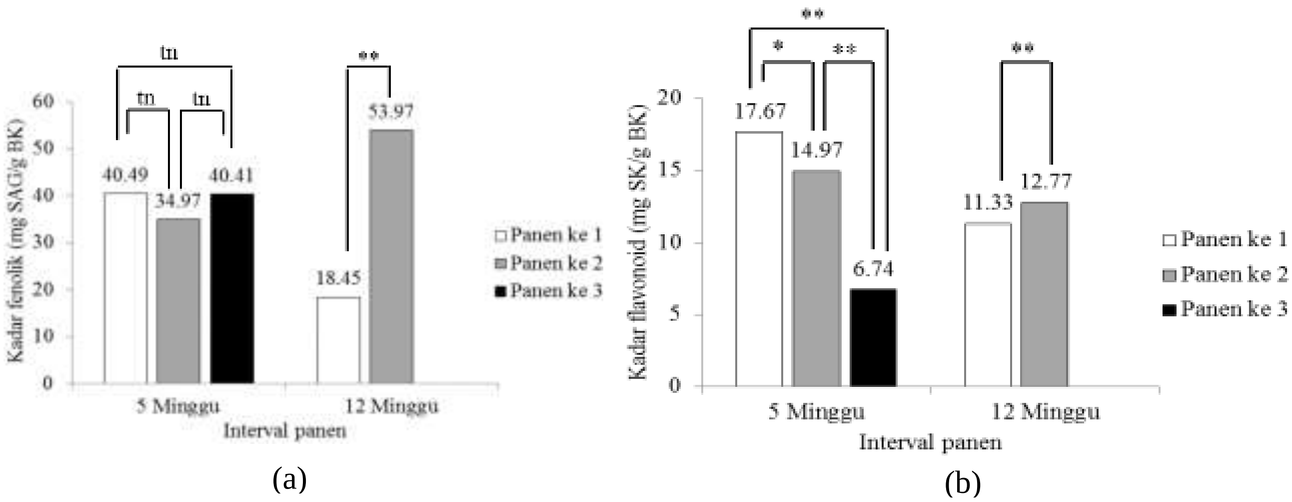
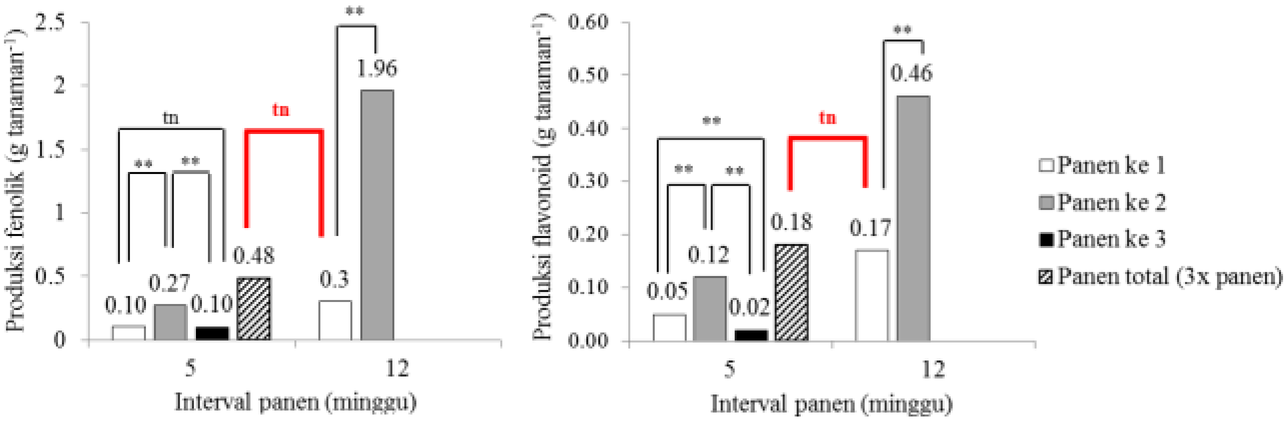



*Figure 5. Phenolic (a) and flavonoid content (b) of orange jessamine at 5 and 12-weeks harvest interval; GAE: gallic acid equivalent, QE; quercetin equivalent, **: significantly different at P ≤ 0.01, ns: not significant at P > 0.05.*

<u>*Metabolites production of per harvest cycle at two harvest intervals*</u>

Phenolic and flavonoid production in the second harvest at the five-week and twelve-week harvest intervals showed a marked increase, then decreased in the third harvest at the five-week harvest interval. Total leaves phenolic production of orange jessamine at the five-week harvest interval for three crops (0.48 g / plant) was not significantly different from the first harvest phenolic production at the twelve-week harvest interval (0.30 g / plant) (Figure 6). The total flavonoids production of orange jessamine leaves at the five-week harvest interval for three crops (0.18 g / plant) was also not significantly different from the production of the first harvest flavonoid at the twelve-week harvest interval (0.17 g / plant) (Figure 6).

The production of secondary metabolites is the result of multiplication of biomass with levels of secondary metabolites in it so that the value is determined by the harvested biomass and also the levels found at harvest. Increased production of active ingredients at the five-week harvest interval in the second harvest cycle is linear due to increased biomass. The production of active ingredients which decreased in the third harvest cycle at the five-week harvest interval was also caused by a decrease in biomass production. Short crop intervals in some plant species can suppress subsequent growth (Taylor *et al*., 1979). In addition, the frequency of harvest and the stage of development of plants at harvest have a major influence on the quality of plant nutrients (Taylor *et al*., 1977).




(a) (b)

*Figure 6. Phenolic and flavonoid production of orange jessamine leaves at 5 and 12-weeks harvest interval; **: significantly different at $P \leq 0.01$, ns: not significant at $P > 0.05$.*

## 4. Conclusion

Proper harvesting arrangements are useful for obtaining optimal harvest biomass with maximum quality and ultimately increasing the efficacy of orange jessamine and maintaining plant growth so that production continuity can continue. The twelve-week harvest interval provides the best biomass and regrowth results for orange jessamine. The increase in PAL activity was not followed by an increase in phenolic and flavonoid levels at the five-week harvest interval. Phenolic and flavonoid production at the five-week harvest interval for three harvest cycles yielded no significant difference from the twelve-week harvest interval during one harvest cycle.

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