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RESEARCH ARTICLE

EFFECT BALANCE OF BOKASHI AND INORGANIC FERTILIZER ON GROWTH, SIMPLICIA YIELD AND CONTENT OF SINENSETIN OF KUMIS KUCING (*Orthosiphon aristatus* (Blume) Miq.)

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ABSTRACT

Growth potential, simplicia yields, and secondary metabolites of sinensetin varieties kumis kucing can be increased through fertilization management. The aim of this research was to examine the effect balance of bokashi and inorganic fertilizer on growth, simplicia yields and secondary metabolites of sinensetin kumis kucing varieties. The design of research was a split-plot field experiment, with the main plot were varieties (Orsina 1 and Orsina 2) and subplots in bokashi fertilization of goat manure (control, bokashi 15 tons ha^{-1}, bokashi 15 tons ha^{-1} + 100% inorganic fertilizer dose recommendation, bokashi 15 tons ha^{-1} + 50% recommended dosage of inorganic fertilizer and 100% recommended inorganic fertilizer). Inorganic fertilizer recommendations consist of Urea 100 kg ha^{-1}, SP36 200 kg ha^{-1}, and KCl 100 kg ha^{-1}. The results showed that the use of bokashi 15 tons ha^{-1} + 50% inorganic fertilizer increased growth. Besides it also produced the highest simplicia of 48.57 g $plant^{-1}$ and the highest secondary metabolite of 0.045% $plant^{-1}$ in Orsina 1. Both kumis kucing varieties did not show growth differences and yields. Bokashi fertilizer can reduce the use of inorganic fertilizers in the growth and simplicia yields and potentially increase sinensetin of kumis kucing.

Keywords: Bokashi fertilizer, Kumis Kucing, Secondary metabolites

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INTRODUCTION

The plant of kumis kucing (*Orthosiphon aristatus* (Blume) Miq.) includes herbaceous perennial plant, which has long been used by the community. Kumis kucing has ability to overcome kidney stones, expend urine, treat inflammation of the urine content and lower blood glucose levels (Kardinan & Ruhnayat, 2002), treat rheumatism, prevent and treat diabetes (Indariani et al., 2014), urinary tract disease, oedema, jaundice, biliary lithiasis, hypertension (Hossain & Mizanur, 2015). It is also used as an antioxidant, antiangiogenic, and anticancer (Chai et al., 2014). Even in the industrial sphere, the kumis kucing is used as a natural wood preservative, as it can reduce termite attack (Azis et al., 2013).

The quality of kumis kucing is determined by the secondary metabolite content, which is contained in leaves and a small fraction of stem. Secondary metabolites

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of kumis kucing include flavonoids, polyphenols, active proteins, glycosides, essential oils and potassium, and a few terpenoids. Sinensetin includes flavonoids as a marker compound from kumis kucing because of their most stable existence (Rosita & Nurhayati, 2004). The results of kumis kucing released by the Ministry of Agriculture showed that sinensetin content ranged from 0.01 to 0.09% (Kepmentan, 2014) and around 0.003 to 0.09% (Rostiana et al., 2014).

Kumis kucing consists of 3 varieties based on the main characteristic of flower and stems colors is: Orsina 1, Orsina 2 and Orsina 3. Based on Kepmentan (2014) Orsina 1 variety are marked with purple flowers and purple stems. This variety has the most stable of sinensetin and high reached 0.094%. Orsina 2 varieties are marked with white flowers and green stems. This variety has higher production than Orsina 1, productions are stable and high recovered trimmed. Orsina 3 is characterized by the color of white flowers, brownish green stems. These varieties include environmental specific genotypes. Among these three released varieties, Orsina 1 and 2 are widely planted (Figure 1).

During this time, recommendations for kumis kucing cultivation still use inorganic fertilizer with additional manure (Rosita & Nurhayati, 2004). Though plants to be used as medicines must be free from chemicals, so they must be cultivated organically. Organic fertilizers help to increase or maintain the organic matter in the soil, act as a slow release nutrient for the plants, thus increase or maintain the yield of plants (Eaton et al., 2013). Bokashi is an organic fertilizer by a fermentation process using effective microorganism (EM). Bokashi can increase growth, dry herbage yield and essential oil content of patchouli (Zaman et al., 2010), reduced nematodes reproduction and increase tomato plant growth up to 50% (Roldi et al., 2013), increase the diameter and weight of red onion bulbs (Alvarez-Solis et al., 2016), increasing growth and production of Chinese cabbage (Riry et al., 2013), and increase growth and vitamin C content (Annisava, 2013), and increase growth peanuts (Karimuna et al., 2016). Bokashi use of 15 tons ha^{-1} can increase the growth of sambiloto medicinal plants (Sudarmi & Wartini, 2018), and increase the number of gladiolus flower leaves (Farida & Hamdani, 2001).

The main ingredient of bokashi is goat manure, with coarse granules. Application of fermentation to goat manure is expected to destroy dirt granules so easily absorbed by plants. The application of bokashi on various varieties of kumis kucing is the suggestion of kumis kucing cultivation technology, for the last effect can increase growth, simplicia yield and sinensetin. The aim of the research is to study the effect balance of bokashi and inorganic fertilizer, by reducing the use of inorganic fertilizers, to growth, simplicia and sinensetin kumis kucing of Orsina 1 and Orsina 2 varieties.

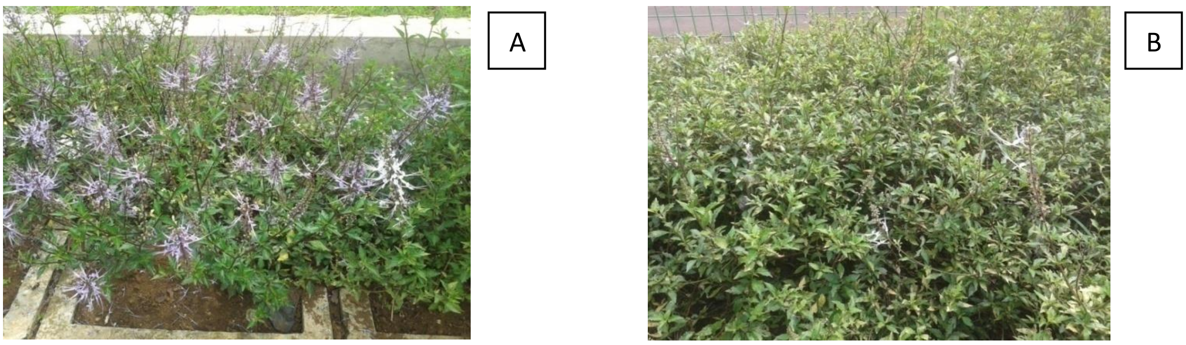

Figure 1. Orsina 1 (A) and Orsina 2 variety (B)

MATERIALS AND METHOD

The research was conducted in the field from September 2016 to January 2017, at Sidoharjo Village, Pringsewu District, Lampung Province, Indonesia. Research using Split Plot Design. The main plot is the variety (V), which is consists of Orsina 2 (V1) and Orsina 1 (V2). Subplot is bokashi fertilization, consist of: without bokashi and inorganic fertilizer (B0), bokashi 15 tons ha^{-1} (B1), bokashi 15 tons ha^{-1} and inorganic fertilizer recommended dosage (B2), bokashi 15 tons ha^{-1} and inorganic fertilizers half of the recommended dosage (B3), and (B4) inorganic fertilizer recommended dosage (Urea 100 kg ha^{-1}, SP36 200 kg ha^{-1}, KCl 100 kg ha^{-1}) (Rosita & Nurhayati, 2004). Each treatment combination was repeated three times. The dosage of the recommendation of inorganic fertilizers based on research that has been done by Balai Penelitian Tanaman Rempah dan Obat (Balittro).

Bokashi fertilizer used primarily raw goat manure, goat feed residue, bran, husk, dolomite, water, and EM. Planting cuttings of kumis kucing are done with a distance of 40 x 40 cm. Observational variables included plant height, number of leaves, number of branches, leaf area, dry weight, secondary metabolite analysis due to the most stable compounds (Rosita & Nurhayati, 2004) and NPK plant tissue analysis. The data obtained were analyzed by variance analysis and a further test was done by using 5% Duncan multiple tests.

The soil used in this study is a clay status based on soil analysis in the laboratory, with low organic C content (1.71), moderate acidity (pH 6.25), and relatively low nutrient content of N, P, K (Table 1). With these soil conditions, for kumis kucing cultivation, it is necessary to add environmentally friendly nutrient sources such as bokashi.

Bokashi used in the study that was analyzed in the laboratory, made from goat manure with quality content of N, P, K of 4.92% and C organic 30.81% (Table 2), so that it meets the standards of Organic Fertilizer based on the Minister of Agriculture Regulation No. 70 of 2011 (Permentan, 2011). The bokashi content is relatively low so it needs to add inorganic fertilizer.

Table 1. Physical character and soil chemistry research place

Parameter	Value	Standard (Balai Penelitian Tanah, 2009)
Texture		
Sand (%)	64.31	Clay
Dust (%)	27.45	
Clay (%)	8.24	
pH H_2O	6.25	Medium
C organik (%)	1.71	Low
N total (%)	0.16	Low
C/N ratio	10.69	Medium
P_2O_5available (ppm)	39.48	Medium
Ca (cmol(+) kg^{-1})	0.27	Very low
Mg (cmol(+) kg^{-1})	0.10	Very low
K (cmol(+) kg^{-1})	0.13	Low
Na (cmol(+) kg^{-1})	0.41	Medium

Table 2. Nutritional elements of bokashi fertilizer

Parameter	Value	Standard (Permentan, 2011)
N (%)	1.90	
P (%)	0.17	
K (%)	2.85	
NPK (%)	4.92	Minimal 4 %
Na (%)	0.44	
Ca (%)	1.39	
Mg (%)	0.72	
C organik (%)	30.81	Minimal 15 %
pH	8.90	4 – 9

RESULTS

The growth of kumis kucing plant described by plant height, number of leaves, number of branches, and leaf area, while the yield of kumis kucing described by dry weight and qualitative by secondary metabolites. Variety treatment did not show any significant effect ($p>0.05$), while fertilization treatment had a significant effect ($p<0.05$) on the growth and yield of kumis kucing.

Plant height

The treatment of varieties did not give a significant effect ($p>0.05$) on plant height, while bokashi fertilization and interaction both had a significant effect ($p<0.05$) (Figure 2). The application of bokashi fertilizer 15 tons ha^{-1} plus 50% recommended dose inorganic fertilizer (B3) on Orsina 1 (V2) showed the highest plant response, which was 69 ± 3 cm and the lowest was B4, inorganic fertilizer recommended dosage (Figure 2).

Number of leaves

The treatment of bokashi fertilization showed a very significant effect ($p<0.01$) on the number of leaves. The highest value in bokashi fertilizer treatment was 15 tons ha-1 and 50% recommended dosage inorganic fertilizer (B3) of 653.16 pieces, while the lowest value was inorganic fertilizer recommended dosage (B4) of 238.33 pieces (Figure 3).

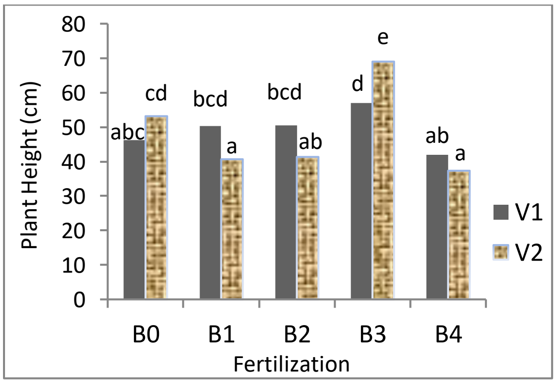

Figure 2. Interaction varieties with bokashi

Number of branches

The number of branches in both varieties showed results that were not significantly ($p>0.05$), while the fertilization treatment on the number of branches showed a very significant effect ($p<0.01$). The optimal fertilizer to increase the number of branches with a composition of 15 tons ha^{-1} of bokashi fertilizer and 50% recommended dosage inorganic fertilizer (B3) resulted in a number of branches 54.83 unit. The number of branches is lowest in treatment inorganic fertilizer recommended dosage (B4) of 21.66 unit (Figure 4).

Leaf area

Fertilization treatment shows the results that have a very significant on leaf area ($p<0.01$). The highest leaf area was found in bokashi fertilizer 15 tons ha^{-1} and 50% recommended dosage inorganic fertilizer (B3) of 2806.75 cm^2, while the lowest was (797.58cm^2) in B4 (Figure 5).

Dry weight of the plant

The bokashi fertilization treatment had a very significant effect ($p<0.01$) on dry weight parameters. The highest dry weight value is in B3 fertilization (48.57 g), followed by B0, B2, B1 and the lowest (8.17 g) was in B4 (Figure 6).

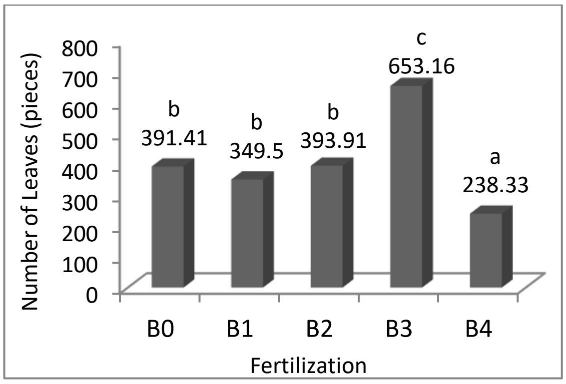

Figure 3. Number of leaves at bokashi fertilization

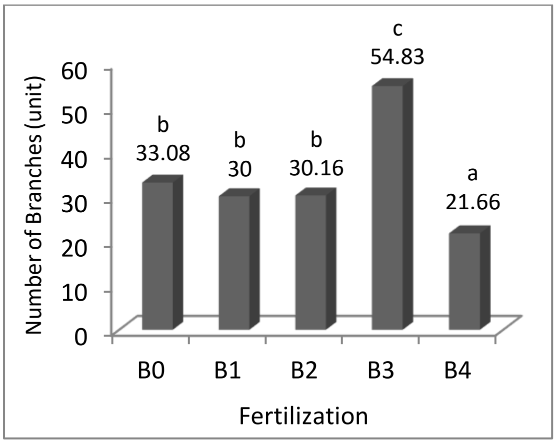

Figure 4. Number of branches at bokashi fertilization

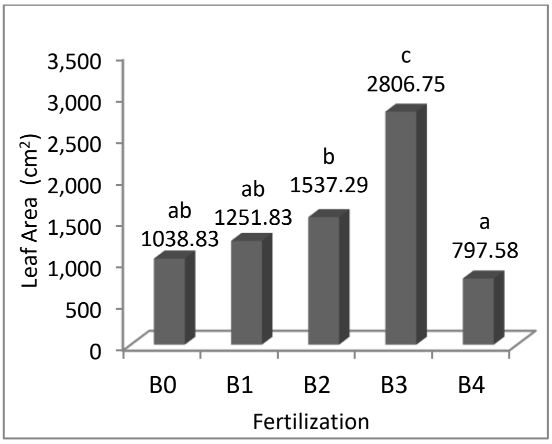

Figure 5. Leaf area at bokashi fertilization

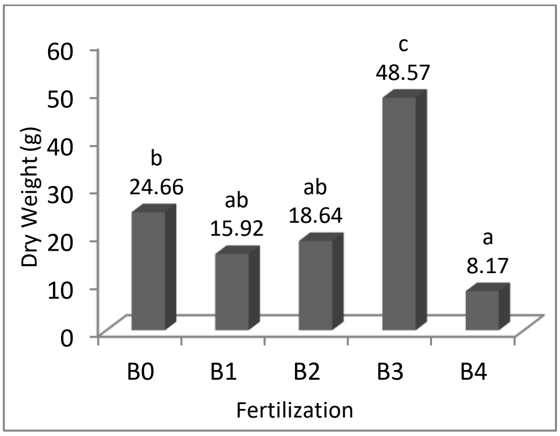

Figure 6. Dry weight at bokashi fertilization

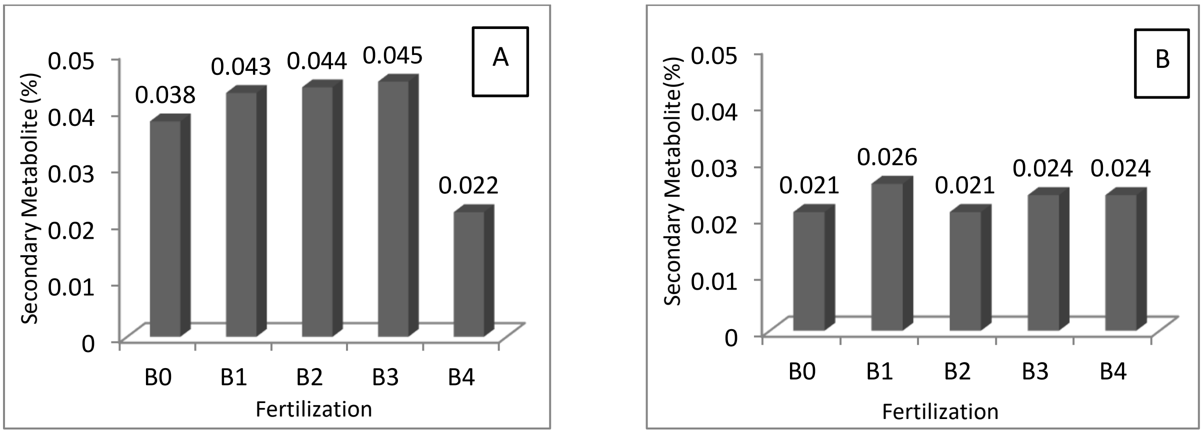

Figure 7. Secondary metabolite Orsina 1 (A) and Orsina 2 (B) at bokashi fertilization

Secondary metabolite

The highest secondary metabolites sinensetin content in Orsina 1 was B3 treatment (0.045%) and in Orsina 2 was B1 treatment (0.026%), while the lowest in Orsina 1 (0.022%) was B4 treatment and in Orsina 2 (0.021%) was B0 and B2 treatment (Figure 7).

Availability of soil nutrients

The availability of nutrients in the soil is indicated by soil analysis carried out after planting. Data on soil nutrient availability is presented in Table 3.

Table 3. Availability of soil nutrients

Perlakuan	pH	C-Org (%)	N-Tot (%)	C/N Ratio	P2O5 (ppm)	Ca (cmol kg-1)	Mg (cmol kg-1)	K (cmol kg-1)	Na (cmol kg-1)	CEC (cmol kg-1)
V1B0	6.59	1.19	0.10	11.56	92.47	3.83	1.17	0.18	0.77	5.32
V1B1	6.51	1.19	0.10	14.57	255.14	3.07	1.19	0.76	0.62	4.64
V1B2	6.75	1.29	0.12	10.45	689.57	3.70	1.73	1.30	0.65	6.69
V1B3	6.73	1.10	0.09	11.79	251.72	3.02	1.02	1.06	0.72	5.48
V1B4	6.28	1.00	0.09	10.93	321.24	3.57	0.77	0.83	0.55	5.24
V2B0	6.34	0.60	0.10	6.18	59.92	3.39	0.95	0.37	0.95	4.44
V2B1	6.65	0.94	0.09	14.64	248.67	3.36	1.64	1.15	0.70	4.57
V2B2	6.57	1.03	0.10	10.97	495.99	3.26	1.43	1.34	0.76	5.45
V2B3	6.33	1.00	0.10	10.01	239.50	2.61	1.18	0.88	0.98	4.64
V2B4	6.53	1.05	0.11	9.52	496.07	3.60	1.15	0.60	0.76	4.75

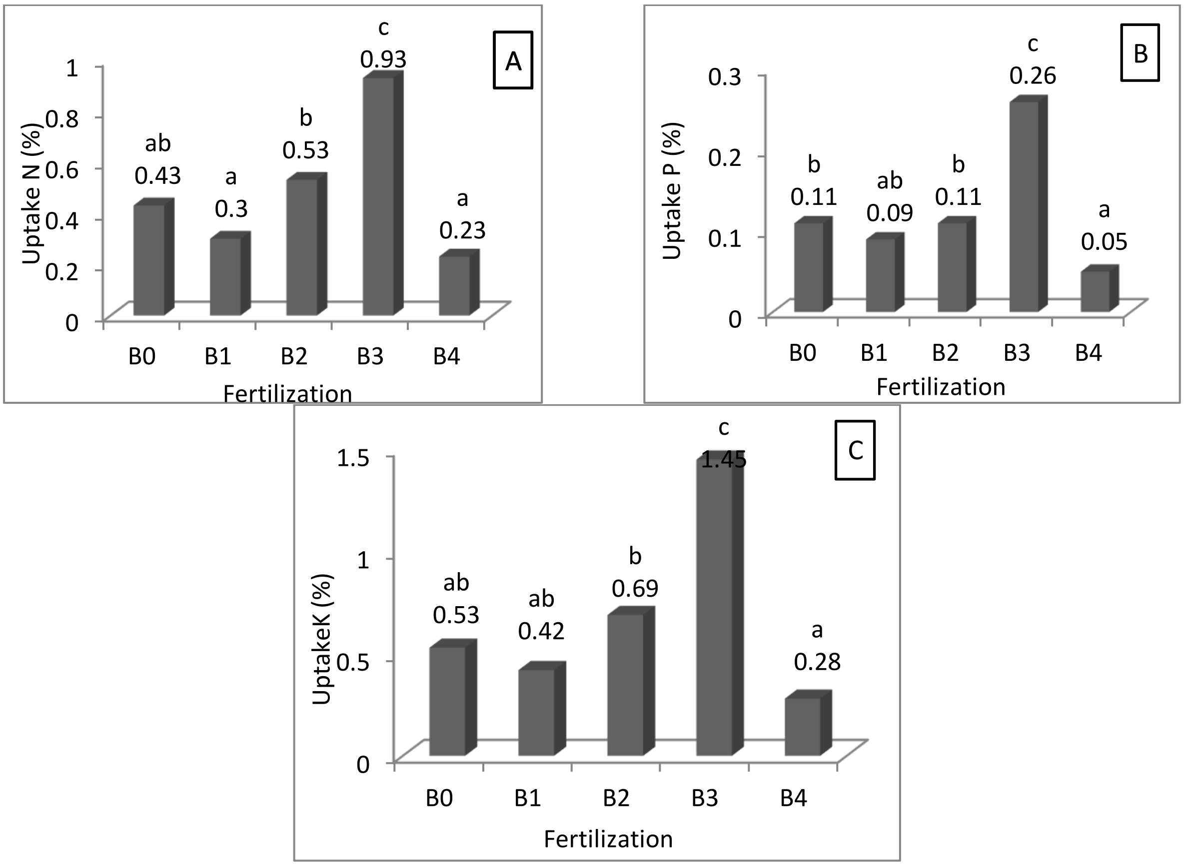

Figure 8. Nutrient uptake N (A), P (B) and K (C) at bokashi fertilization

Uptake of nutrients

Fertilization treatment showed a significant effect ($p<0.05$) on plant nutrient uptake of elements of N, P and K (Figure 8), but the treatment of varieties did not affect ($p>0.05$) the nutrient uptake value. In nutrient uptake of N, the highest value was in the treatment of B3 (0.93%) while the lowest was in treatment B4 (0.23%) (Figure 8A). In nutrient uptake of P, the highest value was in the treatment of B3 (0.26%) while the lowest was in treatment B4 (0.05%) (Figure 8B). In nutrient uptake of K, the highest value was in the treatment of B3 (1.45%) while the lowest was in treatment B4 (0.28%) (Figure 8C).

DISCUSSION

The growth of simplicia kumis kucing on the treatment of both Orsina varieties starting from the beginning of planting to harvest showed results that were not significantly different (p>0.05), but the fertilization treatment affected growth. B3 fertilization treatment gave the highest results in plant height in Orsina 2 at 69±3 cm as shown in Figure 2B. Application of bokashi combined with urea, SP36, and KCl fertilizer can increase the nutrient availability in the soil (Table 3) so that it can increase the growth of kumis kucing, especially the plant height. According to Saragih et al. (2013), plant height will increase along with the addition of N nutrient. Nitrogen is a component of amino acids, nucleic acids, and chlorophyll (Boroomand & Grouh, 2012), which speeds up overall growth, especially stems and leaves. P element plays a role in cell division and extension to increase plant height. Addition of K elements can spur plant growth at the initial level, strengthen the stiffness of the stems thereby reducing the risk of not easily falling down (Lingga et al., 2003).

Bokashi fertilizer treatment of 15 tons ha^{-1} and 50% of inorganic fertilizer showed the highest growth in the number of leaves (653.16 pieces), on the number of branches (54.83 unit) and also in the leaf area (2806.75 cm^2) in Figure 3, 4, and 5. At the beginning of the growth of nutrients from inorganic fertilizers give a faster effect, then continued nutrition from bokashi fertilizer which is slower available. The application of bokashi and inorganic fertilizer will increase nutrient availability, which is useful for plant growth, especially in the vegetative period. Gardner et al. (1984) explained that plant growth is influenced by the availability of nutrients, which causes a smooth metabolic activity of the plant so that the process of cell division, cell extension, and tissue formation increases which eventually results in plant growth. In addition, the application of fertilizer will increase the amount of N which gives effect to photosynthetic devices such as growth and leaf area (Bojović & Marković, 2009).

The treatment using only inorganic fertilizers was recommended (B4), showing rather slow growth, seen in the number of leaves (238.33 strands), number of branches (21.66 pieces) and leaf area (797.58 cm^2) as in Figure 3, 4, and 5. The use of inorganic fertilizers (urea, SP36, and KCl) can quickly provide nutrients for plants but the nutrient uptake contained in plants is even the lowest (0.23%, 0.05%, and 0.28%) such as Figure 8. It is possible for inorganic fertilizers to overdose. This is also in research Satria et al., (2015), excessive inorganic fertilizer suppresses growth rates, unbalanced nutrient availability in the soil, and disrupts the physiological process.

In the control treatment, plant growth (height, number of leaves and number of branches) showed quite high results. This shows that at the beginning of growth until harvest, plant nutrients are fulfilled from the soil and the rest of the soil from nursery polybags with nutrients content such as Table 1.

The yield of kumis kucing in the form of simplicia as indicated by dry weight, showed the highest yield as well as fertilization with B3 as 48.57 g (Figure 6). The dry weight of plants results from plant growth during the vegetative period and the beginning of the generative period, both from plant height, number of leaves, number of branches to leaf area. Hayati (2006) states that the increasing number or area of leaves increases photosynthetic capacity. Photosynthesis which runs effectively will then increase the dry matter of the plant.

Secondary metabolites are compounds that are not essential for the growth of organisms and are found in unique or different forms between one species and another.

Secondary metabolites of plants are very diverse, and some of them have been identified. Secondary metabolites function to protect plants from unfavorable environments and attacks from other interspecies (Kabera et al., 2014). One of the secondary metabolites of kumis kucing is sinensetin.

In Orsina 1 (V2) varieties, the highest sinensetin results were B3 (0.045%), followed by B2 (0.044%), B1 (0.043%), B0 (0.038%) and B4 (0.022%) as Figure 7A. In B4 treatment, the results of the secondary metabolites obtained were slightly different from the other four treatments. This shows that the use of bokashi in Orsina 1 varieties can slightly increase the concentration of sinensetin. The giving bokashi (B1, B2, and B3) can increase sinensetin levels compared without giving bokashi (B0 and B4). This is also in line with the research conducted by Adriana (2014), by providing organic fertilizer can increase the secondary metabolite content of curcumin in turmeric.

In Orsina 2 (V1) varieties, sinensetin on all four fertilization treatments and without fertilization, the difference in results is not very different. This can be seen in Figure 7B, where the five treatments are only the difference in the results of secondary metabolites 0.002 - 0.005%. The highest results were in treatment B1 (0.026%), followed by the same results between B3 and B4, as well as the same results for B2 and B0 of 0.021%. This shows that bokashi and inorganic fertilizers on Orsina 2 varieties have less effect on the resulting concentration of sinensetin.

The availability of nutrients in the soil is indicated by soil analysis carried out after planting such as Table 3. While the treatment of varieties does not affect all elements of soil analysis. Availability of soil nutrients, increasing with the addition of bokashi and inorganic fertilizers. Addition of organic C will affect soil properties by increasing macronutrients such as P and Mg. The existence of C-organic in the soil will stimulate the activities of microorganisms so as to improve the process of soil decomposition and also reactions that require the help of microorganisms such as the dissolution of P, thus increasing the existing P nutrient (Utami & Handayani, 2003). Organic C will also facilitate the release of plant nutrients such as Mg, although in relatively small amounts (Purwono & Purnamawati, 2007). Organic C is a functional part of soil organic matter (Nariratih et al., 2013).

The addition of nutrients through bokashi fertilization and inorganic fertilization will increase the uptake of plant nutrients, especially macro elements N, P and K. The highest nutrient uptake of N, P and K was treated with bokashi fertilizer 15 tons ha^{-1} and 50% inorganic fertilizer recommendations with a value of 0.93%, 0.26% and 1.45% (Figure 8). Uptake of plant nutrients tends to increase with the addition of fertilizer. While, the nutrient uptake of plants without fertilizer is less increase, due to complete the needs of the plant from nutrients availability at the beginning of planting. Plant nutrient uptake is used to process plant growth and the results of simplicia kumis kucing.

The application of bokashi 15 tons ha^{-1} on kumis kucing plants can increase the growth and yield of simplicia. This is in line with the research conducted by Karimuna et al. (2016), giving bokashi can increase the yield of corn and peanuts grown in marginal soil. Bokashi which contains various nutrients can increase the number of nutrients in the soil needed by plants. According to Pangaribuan & Pujisiswanto (2008), bokashi fertilizer can increase the number of nutrients in the soil, especially elements of N, P and K, improve soil and groundwater air conditioning, so that the roots of plants will develop well and the roots can absorb more nutrients.

In addition, giving bokashi fertilizer will reduce dependence on inorganic fertilizer, which is certainly good for land and for medicinal plants that should be free of chemicals. The application of bokashi on kumis kucing can reduce the use of inorganic fertilizer by 50%. This is also in line with research conducted by Pangaribuan et al. (2012), that the addition of bokashi manure can save up to 50% inorganic fertilizer use on tomato plants. The use of bokashi fertilizer 20 tons ha^{-1} in corn plants can reduce inorganic fertilizer by 50% (Yuliana et al., 2015). Provision of bokashi will reduce dependence on inorganic fertilizers, which is certainly good for the soil and medicinal plants that must be free of chemicals.

CONCLUSION

The treatment of 15 tons ha^{-1} bokashi fertilizing and half inorganic fertilizer recommended, the highest yield on all growth parameters and yield, from plant height (63 cm), number of leaves (653.16 pieces), number of branches (54.83 unit), leaf area (2806.75 cm^2), and dry weight (48.57 g) of plant. The use of bokashi fertilizer can reduce the use of inorganic fertilizer (urea, SP36, and KCl) by 50 %.

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