

Effect bulking agent on composting mexican sunflower (*Tithonia diversifolia* L) biomass and utilization on pak choi production

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ABSTRACT: Mexican sunflower or paitan in Indonesian (*Tithonia diversifolia* L) is a weed with high biomass production with nutrient quality that potentially use as composting material. However, there were problem for for optimize composting process due to low C/N ratio and high moisture content of this material. Therefore co-composting with higher C/N ratio and low moisture bulking materials to attain a proper composting process. Research to (1) Evaluate the effect of raw rice husk (RRH) and rice husk charcoal (RHC) as bulking agent on quality of compost *T. diversifolia*. Two composting mixture were TRRH = biomass *T. Diversifolia* + raw rice husk and TRHC = *T. diversifolia* biomass + rice husk biochar. Data were analyzed descriptively and compared with National Standards of Organic Fertilizer SNI 19-7030-2004. (2) To Compare the effect TRRH and TRHC compost on growth and yield of pak choi (*Brassica rapa* var chinensis). Plant height, number of leaves, leaf area, edible and total fresh weight and N uptake analyzed with ANOVA and mean diference with Tukey/HSD test. The results showed that (1) *T. diversifolia* L compost has nutritional quality of N, P, K in accordance with SNI 19-7030-2004, but the levels of N, P and K in TRHC > TRRH. (2) TTRH₄₀ planting media gave maximum growth and yield of pakchoy compared to other treatments. The study confirms that composting *T. diversifolia* L biomass were potential to enhance pak choi production while promoting cultivation of vegetables for food security.

Keywords: compost, pak choi, raw rice husk, rice husk biochar, *Tithonia diversifolia* L

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INTRODUCTION

Food safety issues and environmental concerns about effect of the intensive use agrochemical in green revolusi era has contribute to development of organic farming over the last years. Compost almost use as a soil fertilizer or soil conditioner and to substitute commercial fertilizers in crop production. It has organic matter and nutrients content are valuable materials for increasing chemical, physical, biological properties of soil, stimulating root respira-

tion and improve plant growth and yield (Cayuela et al., 2009; Guo et al., 2012). Compost is a product of breakdown biodegradable organic materials by microrganism into stabilized materials under controlled condition (de Bertoldi et al., 1983; Hubbe et al., 2010).

Mexican sunflower (*Tithonia diversifolia* L) or paitan in Indonesian is a weed plant that can survive in all soil conditions including critical soils with biomass production 2-4 ton.ha⁻¹.year⁻¹ and higher nutrient value compare to

animal manure. This biomass often used as a soil amendments and an alternative nutrient source (Munir & Swasono, 2012; Ojeniyi et al., 2012; Olabode et al., 2007; Pardono, 2011). This biomaas potentially used as the main ingredient for composting. However, it has C/N ratio <15 where it were lower than those recomended for composting process (Bernai et al., 1998; Cayuela et al., 2009; Sahwan, 2004; Sweeten & Auvermann, 2008) caused fast mineralization nutrient especially in inital composting process that potential losses (Mahimairaja et al., 1994). Beside it, high moisture content of these biomass filled air pores and inhibit oxygen circulation or anaerobic condition. This condition can disrupt activity of microorganisms for decomposition process. Excessive moisture content of compost pile are leached also carry out dissolved nutrients that substantially reduces the nutrient value of the compost product (Adhikari et al., 2009; Maurya et al., 2018; Sundberg, 2005; Tiquia & Tam, 2000).

Previous study showed that co-composting high C/N and low moisture bulking material (*bulking agent*) with low C/N ratio and high moisture organic materials were an option strategy to provide optimizing condition for microbial activities on decomposition organic materials (Bernal et al., 2009; Nugroho et al., 2010). Bulking materials modify and prevent physical compaction of substrates, balance C/N ratio of compost pile, increasing aeration rate and improving biological activity conditions and

regulation of moisture (Adhikari et al., 2009; Epstein, 2011; Rosiana et al., 2013; Zaman & Sutrisno, 2007).

Low moisture content of bulking agent can absorb leachate during decomposition and keep the moisture in the pile to sustain the composting process (Adhikari et al., 2009; Iqbal et al., 2012), reduce nutrient losses and thus improving nutrient content of final Products (Gabhane et al., 2012). However, difference of C/N ratio, carbon structure, physical shape, particle size of bulking agent affected water absorption capacity, rate of decomposition, nutrition conserve and quality of final compost (Barrington et al., 2003; Bustamante et al., 2008; Chang & Chen, 2010; Supadma & Arthagama, 2008).

Charred organic material (biochar) that been proposed as novel bulking agent in composting process (Jindo et al., 2012; Yoshizawa et al., 2006, 2005). Biochar has a recalcitrant rich carbon increasing the surface and nanoporosity of the compost matrix and aeration properties (Glaser et al., 2002; Lehmann et al., 2012; Lehmann & Joseph, 2009) to enhance community structure and proliferation of microorganism (Jindo et al., 2012; Pietikäinen et al., 2000; Yoshizawa et al., 2006, 2005) thus the decomposition process takes faster.

Aromatic carbon structures of char absorb inorganic elements, volatile gases, nutrients dissolved (Hua et al., 2009; Steiner et al., 2010) prevent nutrients losses through leaching

and gas volatil and produce a high quality composts (Hua et al., 2009; Steiner et al., 2010).

There were about 20-30% rice husk as waste from rice mill. It has been used as soil amendment or additive/bulking agent in composting (Adhikari et al., 2009; dela Cruz et al., 2006; Dewi et al., 2013; Zaman & Sutrisno, 2007). Convert rice husk by biochar technology to produce a char materials with higher carbon and more pore than raw rice husk (Theeba et al., 2012) that will optimizing composting process and quality of compost. However, information about effect of raw rice husk (RRH) and rice husk char (RHC) on composting *T. diversifolia* L biomass and compare it's potential as soil amandment and fertilizer were scarce. Therefore, we are take more attention about it in this work.

Pak choi (*Brassica rapa* var *chinensis*) is a leafy vegetable with high nutrient content, antioxidant, anticarcinogenic, antiviral properties to maintain human health. The content of vitamins A, C, folic acid, beta-carotene and calcium in pak choi is higher than other types of cabbage (Opena & Tay, 1994; Tshikalange, 2006). Pak choi often widely planted in a pot / container system because it has a shallow root structure (Boonsiri et al., 2009).

Previous study showed that effect compost as component of growing medium to increase pak choi production depend on variation source of compost materials, nutrient content, dosage or composition on growing medium,

and the other aspect as plant growth promoter or toxicity of compost.

The objective of this study were to 1) evaluate the the composting process of *T. diversifolia* L biomass with the addition raw rice husk (RRH) and rice husk biochar (RHC) as bulking agent and 2) compare the effect of persen-tase *T. diversifolia* L compost as component growing on the growth and production of pak choi plants.

The result of this study hopefully will provide practical information to use *T. diversifolia* L biomass compost with different bulking agent as a novel soil amandments and fertilizer on organic agriculture system.

MATERIALS AND METHODS

Research to evaluate quality of compost *T. diversifolia* L biomass with bulking agent RRH) and RHC was conduted at Organic fertilizer production house of Brenjonk Organic Farmer, Penanggungan Village, Trawas District, Mojokerto, East Java whereas analysis of compost quality was conducted at the Soil Chemistry Laboratory, Department of Soil Science, Faculty of Agriculture, University of Brawijaya Malang during October 2012 to January 2013 (12 weeks).

Materials for composting were *Tithonia diversifolia* biomass, raw rice husk, rice husk biochar (Table 1), decomposer solution (water + EM 4+ molasses). Air-dried *T. diversifolia* L biomass (stem and leaves) were cutting manu-

ally into small pieces 3 –5 cm and then mixing homogeneously with bulking agents to desire ratios treatments such as treatments. The mixture of treatments was prepared based on

fresh weight (FW) such as TRRH = 80 % *T. diversifolia* L biomass + 20% raw rice husk and TRHC = 80% *T. diversifolia* L biomass + 20% rice husk biochar (w/w).

Tabel 1. Characterstic of organic materials

Characteristic	Organic materials		
	<i>T. diversifolia</i> L)	Raw rice husk (RRH)	Rice husk biochar (RHC)
Total-N (%)	4.23 ±0.09	1.38±0.06	0.85 ±0.03
Total-P (%)	2.07 ±0.09	1.04 ±0.11	0.63 ±0.06
Total-K(%)	4.08 ±0.16	2.37 ± 0.10	1.87 ±0.11
Total-C.org (%)	31.73 ±1.00	40.28 ±0.76	61.40 ±0.69
C/N	7.51 ±0.16	29.23 ±1.64	72.27 ±1.49
Moisture content (%)	49.30±1.18	15.48 ±0.96	7.10 ±1.26

Compost processed in open windrow composting system with pile dimension were 1.5 m x 1.0 m x 0.5 m. Compost piles were manually turned once time a week.

The effects of these bulking agents on the composting process were evaluated based on the changes in temperature as indicator of compost maturity progress (Adhikari et al., 2009), monitored at : 0, 3, 7, 14,21, 28, 35,42, 49,56 and 63 days.

Quality of compost include total nitrogen (TN), total phosphor (TP), total potassium (TK), total carbon (TC), C/N ratio at intial and final composting process. Samples taked randomly from four spot, dried and grounded to pass through 2 mm sieve for analysis. Data quality of compost were interpretedated by compare mean of nutrient value with the Indonesian National standard of organic fertilizer (SNI 19-7030-2004).

Study to compare the effect of TRRH compost and TRHC compost as component of

growing media on pak choi production conducted in the greenhouse of Brenjonk Organic Farm, Penanggungan Village, Trawas, Mojokerto, East Java during Pebruary to April 2013 use a Completely Randomized Design (CRD) with three replication and six treatments. Treatments consists of percentage *T. diversifolia* compost as soil mixing media such as : TRRH₁₀ = 10% TRRH (v/v), TRRH₂₀ =20% TRRH (v/v), TRRH₄₀ = 40% TRRH (v/v), TRHC₁₀ = 10% TRHC (v/v), TRHC₂₀ = 20% TRHC (v/v), TRHC₄₀ = 40% TRHC (v/v).

Data recorded were plant height (cm), measured from the base of the plant to the tip of the longest leaf and number of leaves (sheet) are counted at 14,24, 34 and 44 days after planting (DAP). Leaf area (cm²) measured with portable leaf area meter (Model- Licor - 300C, Lincon), edible part (fresh leaf and stem) and total fresh (leaf + stem + root) weight measured using an electronic balance, N-uptake de-

terminated by the micro-Kjeldahl method (AOAC, 1984) after harvest.

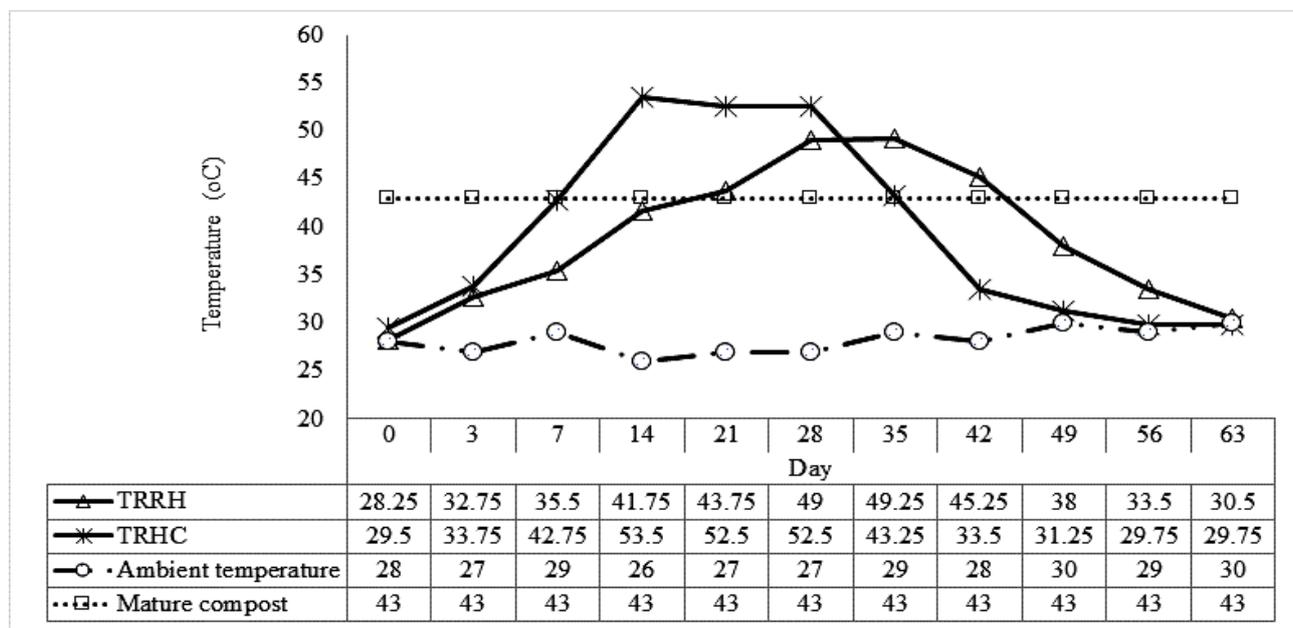
Data were analyzed by analysis of variance (Anova) for a completely randomized factorial design model followed by Tukey/Honestly Significant Difference (HSD) test ($P < 0.05$) to compare means. Pearson's correlations were using to relationship between N-uptake and growth and yield parameter with software SPSS statistical package (SPSS for windows, USA).

RESULTS AND DISCUSSIONS

Effect bulking agent on composting process and quality of compost *T. Diversifolia* L. biomass

Decomposition complex organic material substrate to a simple component by microorganism generated heat. Normally, the compost

temperature went through under three phases during decomposition process such as mesophilic, thermophilic and curing/maturity phase. Mesophylic is the temperature adjustment and maximizing the diversity of microbes to decomposition organic material. These temperature around 35-40°C and then temperature continues rise along with composting time to achieved peak temperature of thermophilic phase or active phase at 45-70°C. Afterwards temperature decreased gradually until reach ambient temperature or curing/maturity phase. The change of temperature correlate with microbial activities during composting process (Kumar et al., 2010; Wahyono et al., 2008). Therefore, dynamic temperature of compost pile were used as parameter to monitor the performance composting process in this study.



Gambar 1. The temperature dynamics on composting processes of *T. diversifolia* L biomass with bulking agent raw rice husk (RRH) and rice husk biochar (RHC).

Dynamic of temperature (Figure 1) showed that there were different trend of temperature dynamic although the initial C/N ratio of TRRH and TRHC compost piles were appropriate recommended range for optimum decomposition (Bernal et al., 2009). TRHC compost pile (C/N = 20.25), mesophilic phase start at 3 days, thermophilic phase reached 43.75 °C (21 days), 49.00 °C (28 days) and 49.25 °C (35 days), curing/maturity phase of 45.25 °C (42 days). While at TRHC (C/N= 29.75), mesophilic phase start at 3 days, thermophilic phase reached 42.75°C (7 days), 53.5°C (14 days), 52.55°C 21 days), 52.55°C (28 days), and reached curing/maturity phase of 43.25°C (35 days). It indicated that TRHC has shorter time to reach the thermopylic/active phase with longer time, higher peak temperature and faster time for lasted composting than TRRH compost. Difference microbial activity due to different initial C/N ratio initial compost mixture (Theeba et al., 2012; Zhu, 2007). Use RHC as bulking agent on *T. diversifolia* L provide balance carbon an nitrogen to support growth of microorganisms and promoted abundance microbial communities. Therefore, THRC has high microbial activity than TRRH. Contrasted with previous works by (Zhu, 2007) that composted swine manure bulking agent saw dust at C/N ratio 25 has the thermophilic phase (>50 °C) at 306 hour while C/N ratio 20 at 286 hour.

Difference of dynamic temperature of TRRH and TRHC compost pile possibly affected

by difference carbon structure of bulking agent. Song et al. (2008) on Theeba et al. (2012) reported that heating/pyrolysis process caused different carbon structure of RRH and RHC. RRH has a relatively smooth surface with a globular structure on the outside and rough space with slit-like cells on the other side while RHC has various opened pores on the rough surface. Yoshizawa et al. (2005) and et al. Yoshizawa (2006) found that aerobic microorganisms proliferated on the surface of the charcoal and in the vicinity of the pore openings. In line with Jindo et al. (2012) also reported that biochar has range of pores properties. Macro pore has selective sorption of organic compounds, while micropore of biochar captured excess moisture content and soluble nutrient to reduce anaerobic sacs in compost piles. These mecahnisms provides aerobic condition and nutrient for proliferation of aerobic microbial (Dias et al., 2010; Tanaka et al., 2006).

Therefore, it expected that presence RHB on THRC compost pile caused the large microbial population and diversity to enhance activity of decomposition process caused generate the temperature to thermophilic range with prolonged peak temperature on active phase and shorter time to reached curring phase compared to TRRH. This findings similar with reported by Theeba et al. (2012) and Dias et al. (2010) that different carbon structure of bulking agent also affected heat generated of composting pile.

Nutrient turnover in composting mixture due to the microbial activity. Total nitrogen (TN) decreased by 58.28% (TRRH) and 31.04% (TRHC) respectively or nitrogen losses on TRHC < TRRH (Figure). Adhikari et al. (2009), Kumar et al. (2010) and Sundberg (2005) found that nitrogen losses on composting process through gasses volatilization NH_3 , N_2O , N_2 , or NO_x compounds and leaching dissolved nitrogen such as NH_4^+ and NO_3^- .

Difference of nitrogen losses of two compost mixture indicated capabilities bulking agent of RRH and RHC to conserve nitrogen and avoid its losses on *T. diversifolia* L compost pile due to different C/N ratio. De Bertoldi et al. (1983) and Tiquia et al. (2002) stated that the high C/N ratio of initial compost mixture affected immobilization of nitrogen or low concentration of mineralization of nitrogen on the compost pile. Therefore, different C/N ratio of RHC > RRH (Table 1) affected higher C/N ratio of initial compost mixture of TRHC than TRRH (Figure 2d), therefore TRHC has a low nitrogen mineralization in initial composting process and potential loss was low too.

Different cation exchange capacity also affected capability bulking agent to reduce nitrogen losses on composting process. RRH Masulili et al. (2010) found that rice husk biochar (RHC) has a high cation exchange capacity than raw rice husk caused it has high ability to adsorption N-ammonium (NH_4^+ -N) and reduce it leached. Adsorption NH_4^+ -N affected in avoid

possibly transformation to NH_3 and NO_3^- (Hua et al., 2009; Masulili et al., 2010).

Biochar on TRHC could retain moisture to reduce anaerobic sacs in compost piles that theoretically can inhibit the transformation of ammonia (NH_3 -N) (Jindo et al., 2012). Biochar reduced the abundance of NO_2 -N producing bacteria, and increase the abundance of N_2O -consuming bacteria affected on low concentration of NO_2 -N (Clough et al., 2013). These mechanisms will prevent nitrogen losses through ammonia volatilization and ammonium or nitrate leaching. Therefore, it probably caused RHC has better ability to reduce nitrogen losses than RRH. Therefore, TRHC compost has highest nitrogen content than TRRH compost.

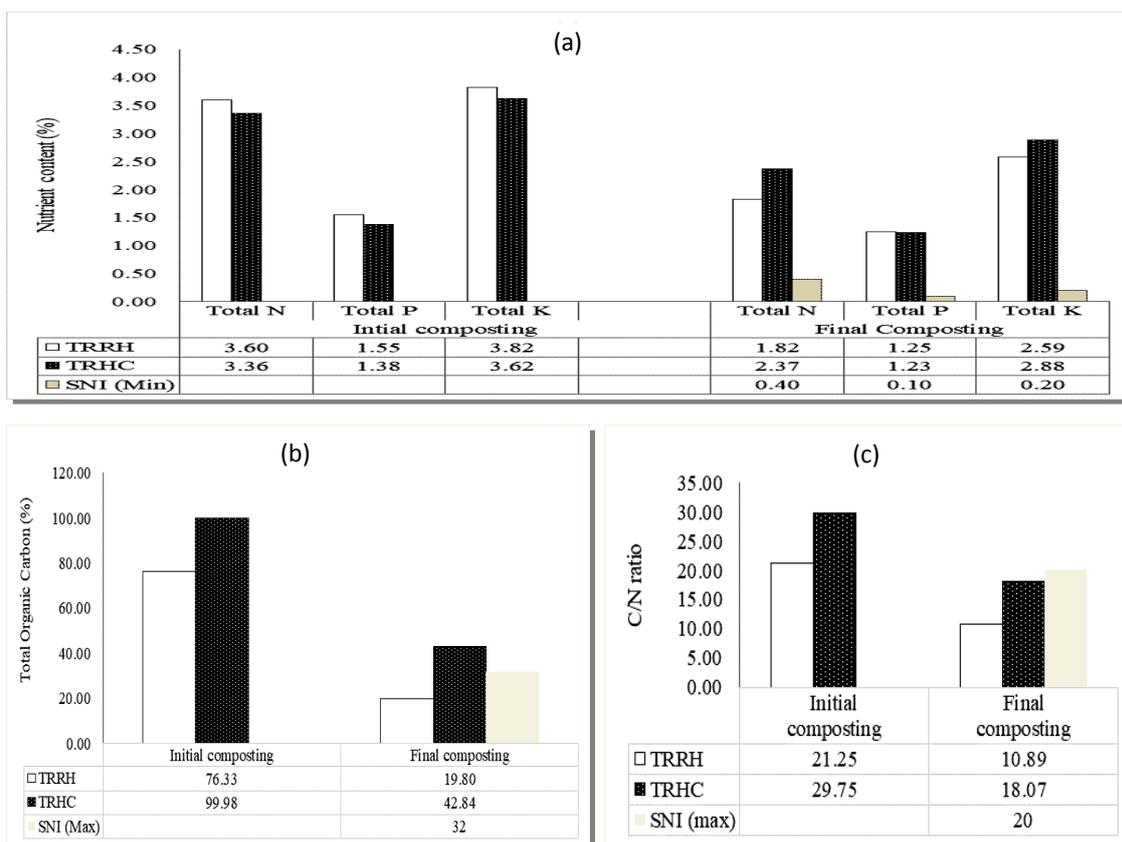
Losses of P and through run-off and leaching (Tiquia et al., 2002). Total phosphorus (TP) decreased by 18.97% (TRRH) and 9.64% (TRHC) respectively (Figure). Phosphorus losses in TRHC < TRRH compost because high carbon content of RHC than RRH affected C/P ratio of composting mixture and mineralization rate of phosphorus organic on beginning composting process (Dias et al., 2010). Therefore, if the concentration is low, the potential for losses by leaching were low too. Biochar has internal porosity, high surface area and surface sites promote absorption of nutrient and have high cation exchange capacity to retain cation include HPO_4^{2-} (Laird et al., 2010; Novak et al., 2009). Therefore, it is assumed that this mech-

anism also caused low losses of P on TRHC compost than TRRH compost.

Potassium (K) losses through leaching mineralized potassium (Rosolem & Calonego, 2013). In this study, total potassium (TK) decreased by 32.20% (TRRH) and 20.22% (TRHC) respectively (Figure) or K losses on TRHC < TRRH because biochar on TRRH has high cation exchange capacity could bind cations such K⁺ or

soluble potassium on compost pile and reduce it leached.

The use of carbonized materials as a bulking agent in composting process increases diversity, and their activity to increase nutrients values of compost (Dias et al., 2010; Jindo et al., 2012; Steiner et al., 2010; Theeba et al., 2012; Yoshizawa et al., 2005).



Gambar 2. (a) Total Nitrogen (TN), Total Phosphor (TP) and total (TK; b) Total Organic Carbon (TOC; c) C/N ratio on composting *T. diversifolia* L with bulking agent raw rice husk (TRRH) and rice husk biochar (TRHC).

During decomposition occurs, microbial utilize carbon as a source of energy and then break down carbon. Temitted CO₂ and CH₄ from composting pile as a metabolic product. It affected declined total organics carbon (TOC) of composting mixture. TOC decreased by 69.69% (TRRH) and 57.12% (TRHC) respectively (Figure

2b) or total carbon losses in TRHC < TRRH. This may be attributed to different carbon structure of bulking agent. RRH has RHC has recalcitrant carbon materials that caused partially decomposition carbon of biochar during the composting process. Therefore, high of C content of

TRHC because presence undecomposed bio-char.

C/N ratio decreased by 41.93% (TRRH) and 30.57% (TRHC) respectively (Figure 2c) due to decrease TN and TC content (figure 2a and 2b). The final C/N ratio of both composts was less than 20, which indicates the achievement of a stable and mature compost (Huang et al., 2004).

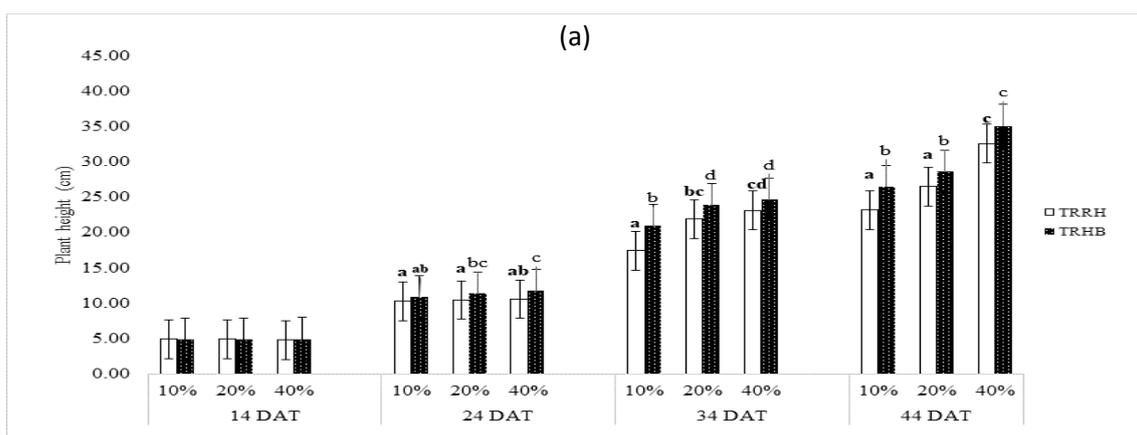
Losses of nutrient reduce the agronomic value of the end-product where N, P, K, C and C/N ratio values of TRRH were 1.72 ± 0.04 ; 1.12 ± 0.09 ; 2.58 ± 0.07 when compared with TRHB 2.31 ± 0.02 ; 1.08 ± 0.05 ; 2.88 ± 0.03 . Hence NPK content of the final compost in present study are has a higher nutritional value than the minimum standard of Indonesian National Standard (SNI) of N,P,K, C and C/N ratio were 0.4 – 3.5% of nitrogen, 0.3-3.5% phosphorus and 0.5 -1.8% potassium.

Effect *Tithonia diversifolia* L compost on growth, yield and nitrogen uptake of pak choi

Anova test showed that significant effect of *T. diversifolia* L compost treatments on plant

height for 24, 34 and 44 DAI, leaf number for 44 DAT, leaf area, edible fresh weight, total fresh weight, N-uptake of pak choi.

Tukey's HSD test showed that maximum plant height of pak choi at 24 DAT were TRHC₄₀ and TRHC₂₀ treatment; at 34 DAT were TRHC₄₀, TRHC₂₀ and CT-B₄₀ treatment; at 44 DAT were TRHC₄₀ and TRHC₂₀. Whereas the minimum plant height of pak choi at 24 DAT were TRRH₁₀; 34 DAT were TRRH₁₀; 44 DAT were TRRH₁₀ and TRHC₁₀ DAT (Figure 3a). Maximum number of leaves of pak choi at 44 DAT were TRHC₄₀ and TRRH₄₀ treatments whereas the minimum were TRRH₁₀, and TRHC₁₀ (Figure 3b). Maximum leaf area were TRHC₄₀, whereas the minimum were TRRH₁₀ and TRHC₁₀ treatments (Figure 3c). Maximum edible fresh weight were TRHC₄₀ whereas the minimum were TRRH₁₀ treatments. Maximum total fresh weight were TRHC₄₀ whereas the minimum were TRRH₁₀ (Figure 3d). Maximum nitrogen uptake were TRHC₄₀ whereas the minimum were TRRH₁₀, and TRHC₁₀ (Figure 3e).



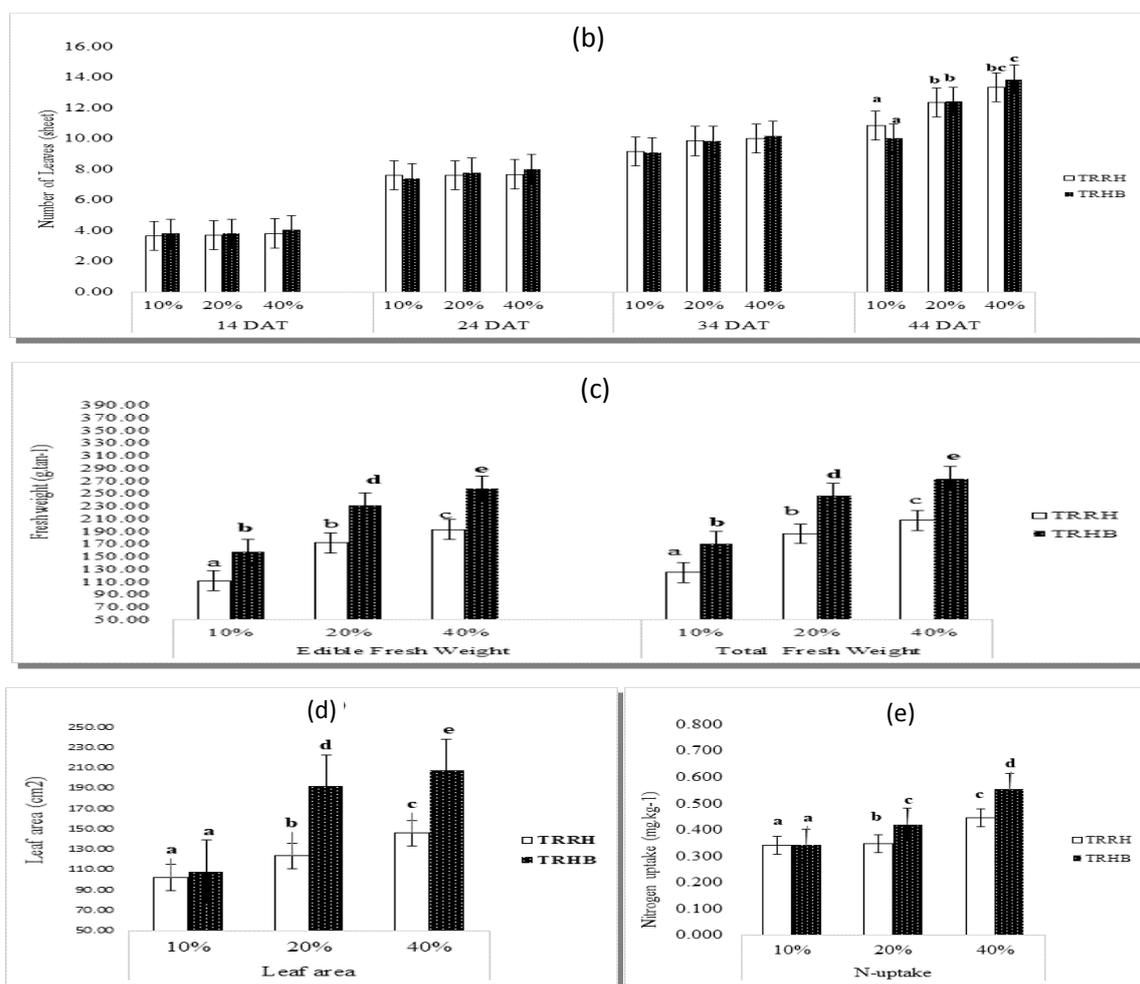


Figure 3. Effect *T. diversifolia* L + raw rice husk (TRRH) and *T. diversifolia* L.+ rice husk biochar (TRHC) compost on plant height (a), number of leaves (b), edible fresh weight and total fresh weight (c), leaf area (d) and N-uptake (e) of pak choi. Vertical bar were standar deviation (n=3). Different letters indicate significant difference at HSD test (P<0.05).

Significant different of N-uptake of the treatments (Figure 3e) probably affected by available nitrogen concentration on growing media that linked with difference of rate of nitrogen mineralization of type of compost and their dose on soil mixture. Total nitrogen content of TRHC compost > TRRH compost (Gambar) has direct contribution to available nitrogen on growing medium. Beside it, these effect maybe associated with synergistic effect biochar and compost of TRHC compost on soil nitrogen dynamic and transformation dan plant uptake

(Clough & Condon, 2010; Glaser et al., 2002; Lehmann et al., 2012). Therefore, it possibly affected on highest N uptake of pak choi on TRHC₄₀.

Biochar increase soil chemical properties such as cation exchange capacity, (Biederman & Harpole, 2013; Gusmailina, 2010; Masulili et al., 2010; Prendergast-Miller et al., 2014; Spokas & Reicosky, 2009) affected absorption of cations N-NH₄ and reduce leaching soluble nitrogen (N-NH₄⁺ and N-NO₃⁻) or gaseous losses (NH₃, N₂ or N₂O). Biochar- compost tends to release its nutrients more slowly providing, decreasing nutri-

ent leaching and therefore persistent in soil to plant uptake (Gusmailina, 2010). Thus with these mechanisms would increase the total pool of available nitrogen to pak choi uptake.

Correlation between N-uptake and the growth and yield of pak choi were very strong ($R > 0.80$) and R^2 value or contribution N-uptake to plant height, number of leaves, leaf area, edible fresh weight and total fresh weight were 87.93%, 67.56%, 72.86%, 70.56% and 71.04% (Figure 4). It indicated that N-uptake has more contributed to increased growth and yield parameters of pak choi.

Nitrogen has been shown plays an important role in plant growth and yields, which as a constituent of chlorophyll that regulate process of photosynthesis. Nitrogen also acts as

a growth regulator such as cytokinins that support cell division and auxin that support the lengthening of cells. The Photosynthates such as polysaccharides, lipids, proteins and amino acids were distributed to cell division in apical shoot meristems and in primordial leaf cells causes an increase in the number of cells. Therefore, the highest N-uptake on TRHC₄₀ increase the amount of chlorophyll formed and the rate of photosynthesis of pakcoy plants. Thus, through the increase in photosynthetic activity of leaves, it further encourages vegetative growth of pak choi such as plant height (Figure 4a), number of leaves (Figure 4b), leaf area (Figure 4c), edible fresh weight (Figure 3d) and total fresh weight (Figure 4e).

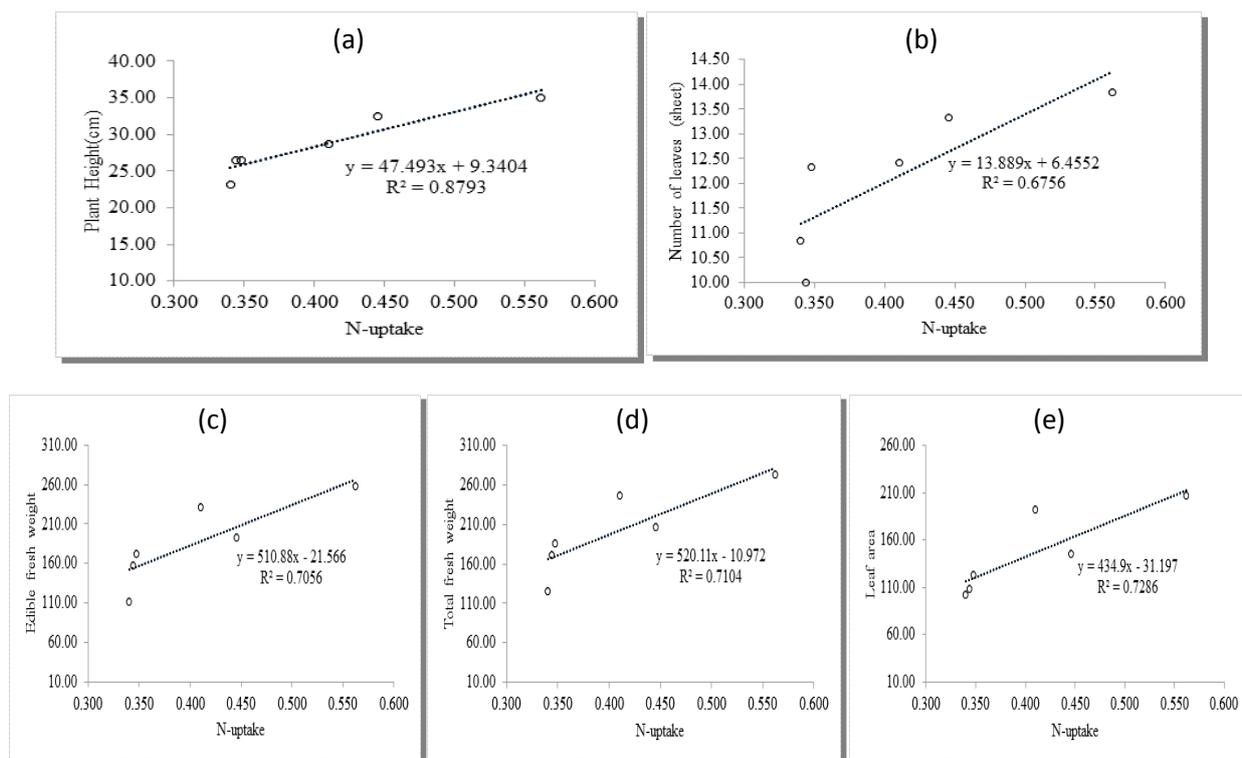


Figure 4. Relationship between N-uptake (X) with (a) plant height, (b) number of leaves, edible fresh weight (c), total fresh weight (d), leaf area (e) of pak choi.

Another possibility for highest growth and yield of pak choi in TRHC₄₀ treatment could be assumed that positive synergistic effects of high nutrient content of *T. diversifolia* L and recalcitrant carbon of rice husk biochar on compost to improve physical structure, chemical properties and biological processes on soil (Gusmailina, 2010; Lehmann & Rondon, 2006) and boosts plant growth (Schulz et al., 2013). Release of nutrients from TRHC₄₀ provide enough nutrients for pak choi and supported by the presence of biochar in THRC which has range of pore sizes. Micropores serve as capillary spaces with high surface area to volume ratios and can retain water dan nutrient. while macropores of biochar can serve as gas exchange channels which can directly influence root respiration (Schmidt et al., 2014).

Asai et al. (2009) and Yu et al. (2013) stated that biochar has potential to increase water holding capacity and increase crop yields in loamy sand soil. Schulz et al. (2013) Prost et al. (2013) found that increased water holding capacity also help retained dissolved nutrient prevent nutrient losses, increase water available for plants and decreased drought stress of plants (Liu et al., 2012; Sohi et al., 2010). The porous structure of biochar were a suitable habitat for microbial proliferation (Tanaka et al., 2006) therefore increase the microbial population and their activity in soils could improve bioavailability of nutrient to the plant and stimulate the release of plant growth promot-

ing hormones which can subsequently affect soil fertility (Schmidt et al., 2014). Similar results were observed Komarayati & Pari (2012), Nur et al. (2014), Schmidt et al., (2014), and Kammann et al. (2014) who reported that addition of positive effect compost-biochar on increase soil fertility and plant production.

Results of the present study give a positive indication that utilization rice husk biochar to optimize composting process of *T. diversifolia* L biomass and produced a nutrient-rich compost with beneficial effects for growing medium.

CONCLUSION

Based on the results of the study it can be conclude that biochar rice husk (RHC) effectively accelerates the composting process and improves the nutrient quality of *T. diversifolia* than raw rice husk (RRH). Application of TRHC compost at a dose of 40% (v/v) (TRHC₄₀) increases nitrogen uptake, plant height, number of leaves, leaf area, edible and total fresh weight of pak choi.

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