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Use of *Tithonia diversifolia* leaves for liquid organic fertilizer

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Abstract In the production of liquid organic fertilizer (LOF) for organic vegetable production, the portion of tithonia leaves determined LOF nutrient compositions. Results showed that P and C-organic contents were significantly affected by the portion of tithonia leaves, yet pH, N-total, K, Ca-*ex*., and Mg-*ex* were insignificantly affected. Treatment with 12.5 % of tithonia leaves had the highest P content, followed by 7.5, 5, and 10 % tithonia leaves. The highest organic C content was found in LOF with 12.5 %, trailed by those of 10, 7.5 and 5 % tithonia leaves. The percentage of tithonia leaves in the production was increased P and C-organic content. The best portion of tithonia leaves for LOF production was 12.5 % of composting materials.

Keywords: Liquid organic fertilizer; Nutrient content; Tithonia diversifolia

Introduction

A wild weed species of Mexican sunflower (*Tithonia diversifolia* that usually grows in the tropical highland areas has been generally utilized in organic horticultural practices, both as mulching and composting materials to preserve soil fertility and yields of many crops (Yelianti *et al.*, 2009; Mustonen *et al.*, 2012; Ojeniyi *et al.*, 2012; Pena *et al.*, 2013; Mwangi and Mathenge, 2014; Taguiling, 2016). Likewise, this weed is additionally utilized as scavenge feed for dairy goats because of its high nourishment substance (Arief *et al.*, 2020). Research conducted in Kenya conducted by Jama *et al.* (2000) revealed that this weed contained about 3.5 % N, 0.37 % P and 4.1 % K. Another research in Nigeria concluded that *T. diversifolia* leaves contained 24.04 %, 1.76 %, 0.82 %, 3.92 %, 3.07 %, 0.005 % and 14.00 % of organic matter, N, P, K, Ca, Mg and C, respectively (Olabode *et al.*, 2007). Recently, Fahrurrozi *et al.* (2017) revealed that tithonia leaves had N, P, K, Ca-*ex*, Mg-*ex*, organic C, dry matter, cellulose and lignin as much as 6.55 %, 0.87 %, 3.94 mg/100 mg, 7.50 Me/100 g, 5,67 Me/100 g, 40.01 %, 12.2 %, 19.91 %, and 5.96 %, respectively.

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Such characteristics brough about this weed could serve as source of organic fertilizers, including as LOF.

Both solid and liquid organic fertilizers could be composed by using tithonia leaves. However, the use of solid organic fertilizer (SOF) could limit nutrient supplies for crops due to longer time of SOF to get mineralized than crop life-cycles (Hartz *et al.*, 2000). The use of LOF through leaves or soil surfaces might improve the effectiveness of SOF application and compensated the slow release characteristic of SOF. Recently, the use of tithonia leaves for LOF had been introduced as a part of LOF materials for organic vegetable production in humid tropical highland of Bengkulu, Indonesia.

According to Taguiling (2013) nutrient contents in SOF increased with the expanding part of tithonia leaves. Yet, no earlier reports of how percentage tithonia leaves affect nutrient contents of LOF. Fahrurrozi *et al.* (2016) employed 5 % of tithonia leaves of all other composing LOF materials. It is important to investigate the fraction of tithonia leaves during LOF production to ensure the sustained availability of this weed in surrounding production areas

This study aimed to determine the effects of tithonia leaves portion in the process of LOF production on LOF nutrient contents.

Materials and methods

The experiment, arranged in complete randomized design with three replications, was conducted in Rejang Lebong, Indonesia (1.015 m above sea level, 3°, 27', 30.38" South Latitude and 102°. 36', 51.33'' East Longitude). Manufacturing of LOF was conducted as method of Fahrurrozi *et al.* (2016). Green biomass of tithonia leaves were harvested from the unflowering branches. Leaves from these branches were chosen because leaves from these sources had higher nutrient content than leaves from flowering branches (de Lima *et al.*, 2015). Preparation of LOF was conducted by mixturing fresh cattle's feces, cattle's urine, tithonia leaves, of topsoil, solution of 24-hour incubated 10 mL EM4+0.125 kg white sugar, as much as 5 kg, 10 L, 2.5 kg, (5/7.5/10/12.5 kg, depending on treatment), and 10 L, respectively. Each mixture was placed in a blue plastic container and supplemented with water to reach a volume of 100 L. Each container was further securely covered and incubated for five weeks. The heaviness of green biomass of tithonia was equivalents to 5 %, 7.5 %, 10 % and 12.5 % of all out weight of materials to deliver LOF. Supplement content investigation for LOF tests were conducted on pH, N-total (%), P-Bray (%), K (%), Ca-*ex* (%), Mg-*ex* (%) and organic C (%) with three replications by using method proposed by Yoshida *et al.* (1976). Results were analyzed with analysis of variance $P<0.05$. Treatment differences were compared using Least Significantly Different $P<0.05$.

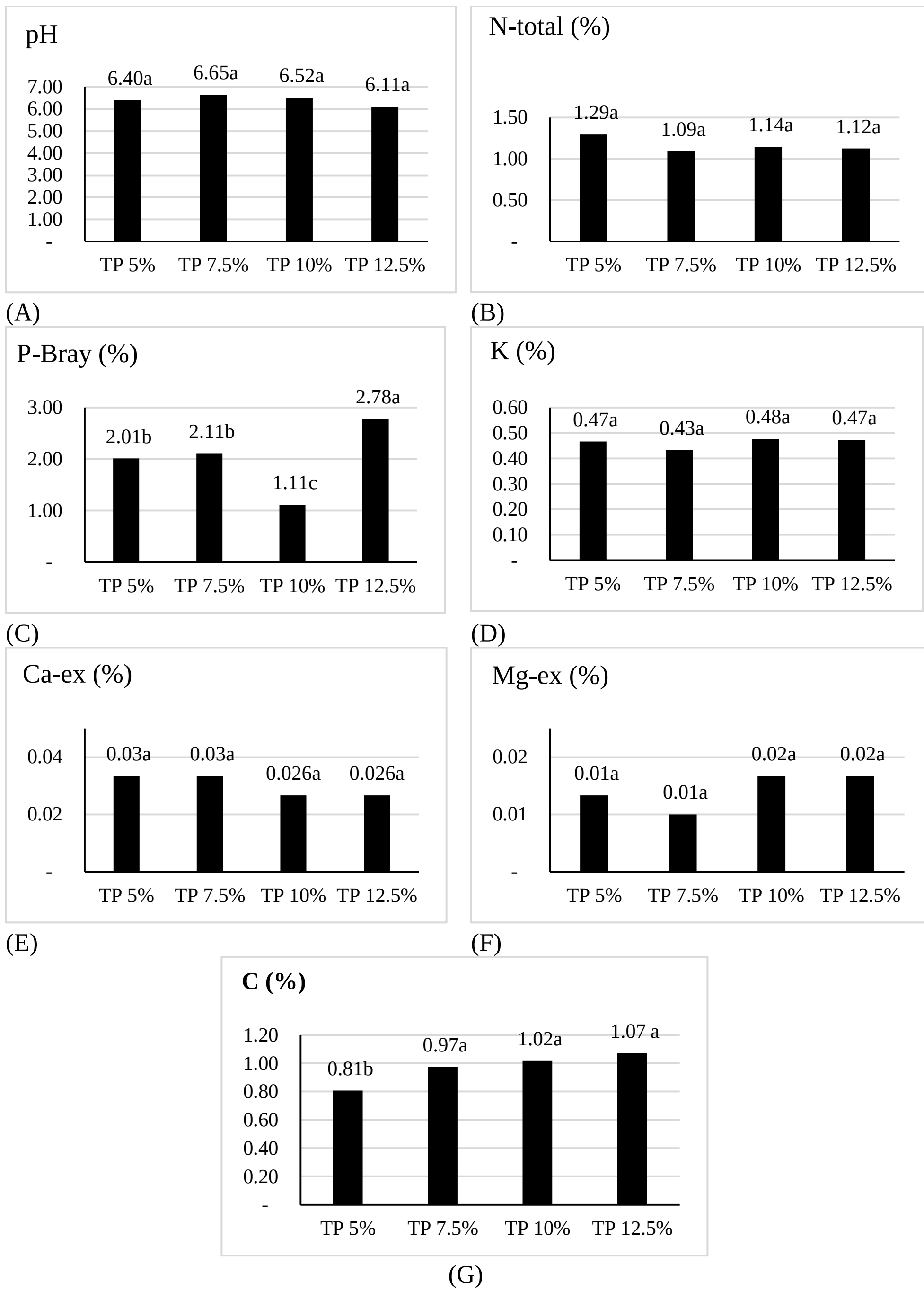

Figure 1. Effects of tithonia leaves portion (TP) on pH of LOF [A], N-total [B], P [C], K [D], Ca [E], Mg [F] and C [G]. (Means of pH followed by the same letter are not significantly different according Least Significant Difference *P<0.05*)

Results

Results revealed that treatments did not significantly affect (*Pr.>F*= 0.3636) the pH liquid organic fertilizer (LOF) (Figure 1-A). So did on N content of LOF (*Pr.>F*= 0.4761) (Figure 1-B), However, tithonia composition significantly affected P contents *(Pr.>F*= 0.013) (Figure 1-C). Results also indicated that treatments also did not significantly (*Pr.>F*= 0.8844) influence K content (Figure 1-D). Furthermore, tithonia leaves composition did not significantly affect (*Pr.>F*= 0.7765) exchangeable calcium (Ca-*ex*) in LOF (Figure 1-E). Insignificant effect (*Pr.>F*= 0.1889) also was noticed on exchangeable magnesium (Mg-*ex*) contents (Figure 1-F). This experiment indicated that tithonia composition significantly affected (*Pr.>F*= 0.0454) C-organic contents (Figure 1-G).

Discussion

The results indicated that tithonia composition treatments produced pH ranged from 6.11 to 6.65 which was close to neutral and did not significantly different among treatments (Figure 1-A). Neutral or closed to neutral pH of foliar fertilizer is a very important for successful applications. According to Ruan *et al.* (2007), solution with closes to neutral pH will be effectively absorbed by plants. Nevertheless, plant responses might be different among crops since each nutrient requires different acidity level (Breeze *et al.*, 1987). These results were similar to those were reported by Annisa & Gustia (2017) who found the pH of 6.78 for tithonia based LOF. This value might continue to rise reaching neutral points with time. It appeared that pH values of LOF were slightly lower compared to those of solid organic fertilizer. For example, pH of 8.5, 8.4, 7.8, and 7.7 were recorded for solid organic fertilizer of cattle, poultry, goat and buffalo composted manures, respectively. Lower pH of LOF in this experiment could have been resulted from active microbial decomposition and accumulation of organic acids during the courses of LOF creation.

In addition, N content of LOF, which was not significantly different among treatments, ranged from 1.09 to 1.26 % (Figure 1-B). Insignificant effects of tithonia leaves' portion on N of LOF could have been resulted from high N content of tithonia leaves (Lestari, 2016) and finally caused similar N contents in LOFs. Although tithonia leaves increased N content in LOF, but bigger portion of tithonia leaves did not elevate N content. It appeared that high N content in green leaves may have prompted denitrification rates, thus expanded N loss through volatilization. N loss might be additionally ascribed to N utilization by decomposers since microorganisms need more N than other nutrients their development and advancements. Likewise, high N content in urine and faces of cattle may have been ignored the impacts of level of tithonia green leaves on N content in LOF. Nevertheless, N content of tithonia based LOF from this analysis is effectively accessible for the plants as demonstrated by its low C to N ratio which went from 1.05 to 1.59. These values were especially higher than that was accounted for by Annisa and Gustia (2017) where tithonia based LOF contained 0.12 % N. Notwithstanding, contrasted to Muktamar *et al.* (2016) who reported N content of 2.4 %, N content from this experiment was much lower.

However, tithonia composition significantly affected P contents with content range of 1.11 % to 2.78 % (Figure 1-C). The highest P content was found in treatment with 12.5 % of tithonia leaves, *i.e.* 2.78 %, followed by those of 7.5 % and 5 %, which were accounted for 2.11 % and 2.01 %, respectively. The lowest P content was recorded on LOF produced by using 10 % of tithonia leaves (1.11 %). These results were higher than previously reported by Muktamar *et al.* (2016), used tithonia leaves that equal to 5 kg (5% of total mixtures), with the magnitude of P contents 0.0146 % and 1.44 %, respectively. In contrast to N, loss of P through volatilizing might be very small, and eventually increased P content of produced LOF.

Results also indicated that treatments did not significantly influence K content in LOF with the magnitude in between 0.43 and 0.48 % (Figure 1-D). Muktamar *et al.* (2016) and Annisa & Gustia (2017) found comparable results with K content of 0.33 % and 0.47 %, respectively. It is generally accepted that solid organic fertilizer (SOF) had higher K than that of on in LOF. Such low K in LOF contrasted with those of SOF may have identified with the establishment of insoluble K complexes within the SOF and also with the change of pH (Irshad *et al.*, 2013). The use of other materials such as cattle's urine, feces, and top soil during the production of LOF which were also contained K might have reduced the treatment effects.

Furthermore, the portion of tithonia leaves in the production of LOF insignificantly affected Ca-*ex* (exchangeable calcium) in LOF with the magnitude in between 0.027 % to 0.033 % (Figure 1-E). These values were considerably low compared to generally shoot Ca concentration of plants. According to Marschner (2012) under natural growing condition, Ca-*ex* shoot of many plants lied in between 0.1 % to 5 %. Such low Ca-*ex* contents in this experiment was presumably related to the state of Ca^{2+} in organic colloids. Most of the organic colloid surfaces are negatively (-) charged, in which allow their surfaces to attract and absorb positively charged ions, such as Ca^{2+}. Consequently, this ion decreased Ca-*ex* content in LOF. Another possibility might be related to the capacity of Ca^{2+} to tie P becoming calcium-phosphate during the LOF decomposition and later lowered the presence of Ca-*ex*. As it was previously discussed, fresh tithonia leaves that had high Ca-*ex* content might be responsible in hastening this binding and eventually declined Ca-*ex* content. This issue ought to be additionally explored to optimize Ca-ex in LOF as the significance of Ca in plant cells and tissues. According to Tuteja & Mahajan (2007) the presence of cytosolic free Ca^{2+} in the plant cells increased crop adaptability to plant hormones, pathogenic elicitor, touch, light and other biotic stressors. Insignificant treatment effects were also found on exchangeable magnesium (Mg-*ex*) contents with the magnitudes ranges from 0.01 % to 0.02 %. This nutrient is very important for plant during the chlorophyll formation and activates many enzyme activities. Insignificant effect on Mg-*ex* content could have been attributed to status of Mg^{2+} to be firmly confined by organic colloids. In addition, the capacity of Mg cation to bind P during the LOF production might have been sped up and eventually brought about declining Mg-*ex* in LOF.

Results also indicated that tithonia composition significantly affected C-organic contents in LOF within the span from 0.81% to 1.07% (Figure 1-G). High organic C in tithonia leaves, 40.01 % (Fahrurrozi *et al.*, 2017), could have resulted in significant effects of the treatments. Organic C resulted from this experiment was closed to that was reported by Annisa & Gustia (2017) who found that tithonia based LOF had 1.22 %. Decreasing organic C in LOF was seemingly resulted from of organic C consumptions by decomposers during the courses of LOF production.

In conclusion, increasing percentage of *T. diversifolia* leaves during the production of tithonia-based liquid organic fertilizer augmented P and organic C content of liquid organic fertilizer. However, treatments did not increase the pH, N-total, K, Ca-*ex*, Mg-*ex*. contents in the liquid organic fertilizer. A higher part of green biomass of *T. diversifolia* leaves might be further evaluated to have higher nutrient contents.

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