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Growth and yield responses of cauliflower on tithonia (*Tithonia diversifolia*) compost under organic farming practices

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Abstract Recently, organic cauliflower has been highly demanded in Indonesia since the horticultural product is healthier and pesticide free. The effect of tithonia (*Tithonia diversifolia*) compost on the growth and yield of cauliflower under organic farming practice was determined. The experiment was carried out at CAPS Research Station in Air Duku Village, Rejang Lebong District, Indonesia, located at 1054 m above sea level. The treatments consisted of 0, 5, 10, 15, 20, and 25 ton of tithonia compost ha^{-1}. Tithonia compost contained 0.85% nitrogen, 0.22% phosphorous, 0.63% potassium and pH of 8.5. The result indicated that application of tithonia compost at the rate of 20 ton ha^{-1} exhibited highest plant height and number of leaves as compared to the other treatments. An insignificant difference of plant height and leaf dry weight was detected among treatments of 20 and 25 ton ha^{-1}. The curd diameter and total plant dry weight were recorded. Likewise, the greatest fresh curd weight was observed at the compost application of 25 ton ha^{-1}. Curd diameter of cauliflower fertilized with 20 ton ha^{-1} was 12.8%, 17.5%, and 72.8% larger than those of 15, 10, and 5 ton ha^{-1}, respectively while curd fresh weight at the rate of 25 ton ha^{-1} was 44.9%, 51.5%, and 100% greater than those of 20, 15, and 10 ton ha^{-1}, respectively. Nonetheless, the yield of the cauliflower was lower than its potential.

Keywords: Brassica oleracea, organic fertilizer, Tithonia

Introduction

Agrochemicals such as synthetic pesticides and fertilizers are being used intensively, even though they have negative impact both on the environment and farm product. As public concern grows, these issues are seen as increasingly important. To overcome these issues, there are several ways of growing plants that environmentally sound such as sustainable agriculture, permaculture, minimal cultivation, crop rotation and organic agriculture (Mason, 2003).

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Closed agriculture is another organic agriclture which makes use of local resources intensively to improve farming efficiency. In the system, agro-ecosystem receives agrochemicals such as organic fertilizer and pesticides primarily from recycle waste of agriculture farming and animal inside agro-ecosystem, therefore, integrated farming involving agriculture practice combined with animal farm is a must. On the other hand, agrochemical input from outside agroecosystem is minimized even completely free.

Organic Agriculture avoids the use of synthetic pesticides and fertilizers and relies on biological pest control, crop rotation, green manure, compost and other recycle wastes to maintain soil fertility (Nandwani and Nwosisi, 2016). Organic matter provides much of the soil's capacity to store nutrients and water. It plays a critical role in the formation and stabilization of soil structure, which in turn produces good tilth and drainage and resistance to erosion. It can not only carry and make available nitrogen, sulphur, and phosphorus but also improves the availability of nearly all nutrients. Therefore, soil organic matter influences the physical, chemical and biological properties of soils which are indirectly influence plant growth.

Organic matter consists of decomposing plant and animal materials and microbes from a variety source such animal dung from cattle, horses, chicken, farm product waste, municipal waste as well as weeds. Agriculture wastes such as oil palm fruit bunches, chrysanthemum residue, soybean, and vegetable has been evaluated by Farahzety and Aisha (2013). Weed as a wild and unwanted plant such as thitonia can be used as a source of organic material.

Organic fertilizer of tithonia (*Tithonia diversifolia*) provides an advantage of improving soil fertility and indirectly influences plant growth and yield. Application of tithonia organic fertilizer exhibits an increase in total soil nitrogen, NO_3-N, exchangeable K and soil pH (Muktamar *et al.*, 2017; Agus *et al*., 2009), soil P, Ca, CEC, K and soil organic matter (Shokalu, 2010; Kolawole *et al*., 2014). Application of tithonia organic matter also increase kales fresh weight (Mwangi and Mathenge, 2014), maize yields (Opala *et al.*, 2015), growth and yield of tomato (Aghofack-Nguemezi and Dzukam, 2016), number of leaves, plant height and stem girth of celosia (Shokalu, 2010), corn (Nkongolo *et al.*, 2016), as well as growth and yield of sesame (Babajide, 2012). The study intended to determine the effect of tithonia compost on the growth and yield of cauliflower under organic farming practice.

Materials and methods

Study Sites and Tithonia Composting Process

The experiment was conducted at the Closed Agricultural Production System (CAPS) Research Center in Air Duku Village, Rejang Lebong District,

Bengkulu, Indonesia located at longitude between 1020 36‘ 54.96‘‘ E and 1020 36‘ 56.82‘‘ E and a latitude between 30 27‘ 34.26‘‘ S and 30 27‘ 37.02‘‘ S with the altitude at 1054 m above sea level (Muktamar *et al*., 2017).

The fresh shoot of tithonia was collected from the site around the Research Center. Leaves and young stem of tithonia weeds were chopped at approximately 2-3 cm length. Effective microorganism (EM-4) at a concentration of 5 mL L^{-1} water was mixed with the chopped tithonia. The mixture then covered with plastic for a month. During the composting process, the compost pile was inverted every week. The mature compost indicated with brown-black color with no smell and the compost temperature about 27^0C.

Experimental Design

The experiment was a Complete Randomized Block Design replicated three times. The tithonia compost dosage treatments were 5, 10, 15, 20 and 25 ton ha^{-1} and without compost as a control treatment. Three blocks of 7.9m x 6m were established and separated by 50cm between the block. Each block was divided into 7 plots (6m x 0.7m), and each plot was separated by 50 cm. Tithonia compost was incorporated into 0-20cm of soil surface one day before planting at the rate of 5, 10, 15, 20 and 25 ton ha^{-1}according to each treatment.

Field Experiment

Cauliflower var. Snow White seeds were sown in nursery beds (1.5m x 1m) in soil enriched with cow manure at the dosage of 10 ton ha^{-1}. Three weeks after sowing, the seedlings were transplanted to the field. The experimental site was plowed to 20 cm depth using hand-tractor 7 days before transplanting. Tithonia compost was applied at the day of soil preparation. Cauliflower seedlings were transplanted at a spacing of 50cm x 70cm.

Weeding was conducted manually. Replanting was done a week after transplanting for poor seedling growth. Weed control was done manually and pest and diseases control were conducted where necessary. Topsoil application of rabbit urine liquid fertilizer was applied 3 times before flowering at a concentration of 1L urine out of 4L water at the rate of 250mL per plant. Cauliflower growth and yield variables were measured on four randomly selected plant samples in each plot.

Statistical Analysis

Data were subjected to one-way analysis of variance (ANOVA) and means of each parameter that was significantly different at F-test were further separated with Duncan’s Multiple Range Test (DMRT) at $P \leq 0.05$.

Results

Analysis of variance using 95% confidence level shows that tithonia compost affect cauliflower growth and yield, except on the leaf number. Application of tithonia compost on organic managed soil influenced plant height, leaf dry weight, flowering date, curd diameter, curd fresh weight as well as the total plant dry weight of cauliflower.

Plant height

Figure 1 showed that plant height increases linearly as thitonia compost rate increased. Tithonia at 15 ton ha^{-1} increased plant height as much as 25% compared to that of control treatment (with no compost) even though not significantly different from the rate of 5 and 10 ton ha^{-1}. The highest plant height was observed in the rate of 20 ton ha^{-1} (9.25 cm). Figure 1 also shows that at a higher rate of compost (25 ton ha^{-1}), plant height tends to decrease.

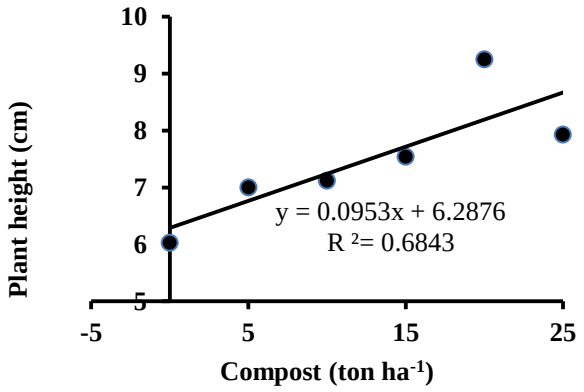

Figure 1. Plant height as affected by tithonia compost rate

Leaf number and dry weight

There are no significant differences in leaf number (Figure 2), however, leaf dry weight increased with increasing compost rate (Figure 3.). Even statistically no different on leaf number, however, the number of leaves tend to increase as the compost rate increased. The highest leaf number was observed at a rate of 20 ton ha^{-1} (9.5) while in control treatment only 6.4. This result indicates that tithonia compost plays an important role in providing nutrients for plants growth indicated by increasing leaf dry weight as increasing the rate of tithonia compost (Figure 3).

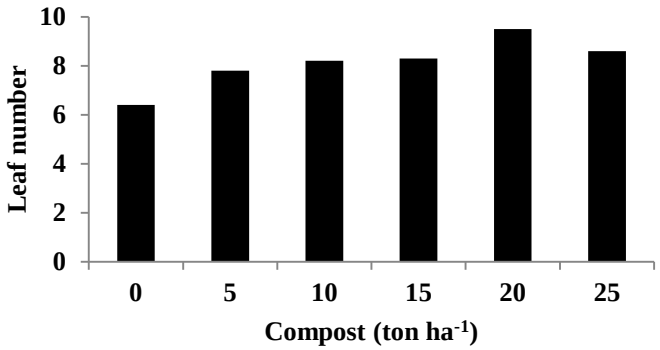

Figure 2. Leaf number as affected by tithonia compost rate

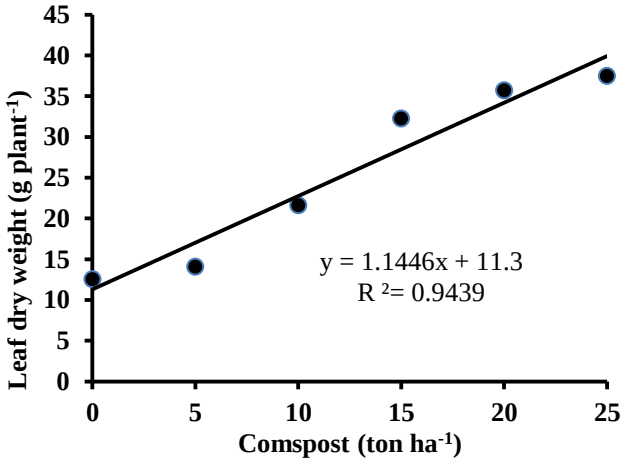

Figure 3. Leaf dry weight as affected by ithonia compost rate

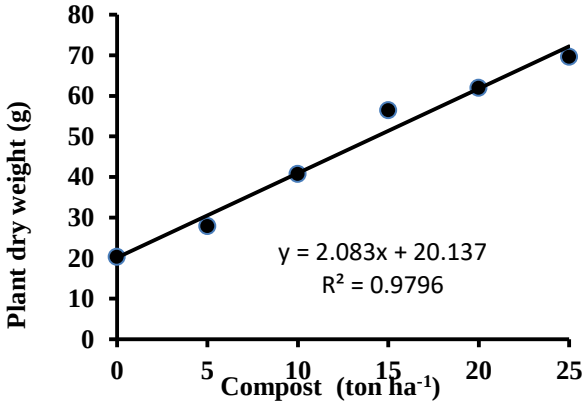

Figure 4. Total plant dry weight as affected by tithonia compost rate

Tithonia compost at 5 ton ha^{-1} has no effect on leaf dry weight. Leaf dry weight was 12.5 cm at control treatment while 14.1 cm at compost rate 5 ton ha^{-1}. However as the rate increases, it is followed by increasing leaf dry weight. At 10 ton ha^{-1}, tithonia compost increased leaf dry weight as much as 72.8% as compared to that of control treatment. The highest leaf dry weight (37.5 g) was obtained from compost at the rate of 25 ton ha^{-1}.

Total plant dry weight

Similar trend to leaf dry weight, total plant dry weight was also increased by increasing the compost rate with the R^2 value of 0.979 (Figure 4). Plant dry weight at the rate of 10 ton ha^{-1} increased twice as much compared to that of control treatment. The highest dry weight was recorded at compost rate of 20 ton ha^{-1} (69.5 g). These results indicate that tithonia compost plays an important role in cauliflower growth.

Flowering day

Tithonia compost accelerates flowering day of cauliflower (Figure 5). Time of cauliflower flowering fertilized with tithonia compost at a rate of 25 ton ha^{-1} was 67 days after planting while 83 days at control plant or 2 weeks earlier. This result indicates that tithonia compost has an important role in plant physiology.

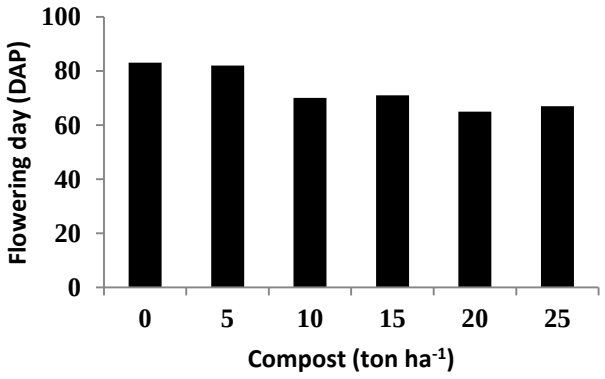

Figure 5. Flowering date of cauliflower as affected by tithonia compost rate

Curd diameter

Figure 6 showed that tithonia compost significantly influenced the curd diameter. Increase in the compost rate followed by increasing the diameter. The

highest diameter (11.81 cm) was observed in the rate of 25 ton ha^{-1} followed by 20 ton ha^{-1} (10.25 cm); 15 ton ha^{-1} (9.09 cm); 10 ton ha^{-1} (8.72 cm) ; 5 ton ha^{-1} (5.93 cm) and the smallest curd diameter was observed from control treatment (3.37 cm). Curd diameter at the rate of 20 ton ha^{-1} was almost triple as high as control treatment indicating that compost has an important role on the growth and yield of cauliflower.

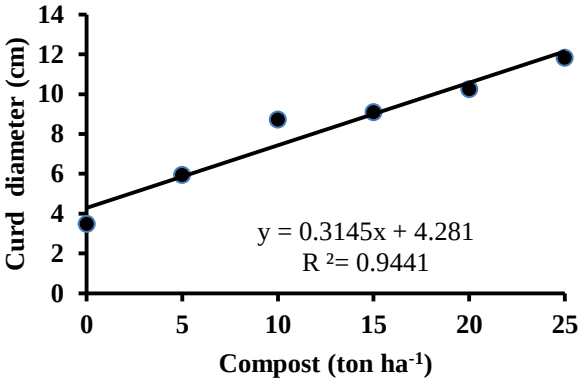

Figure 6. Curd diameter as affected by tithonia compost rate

Curd fresh weight

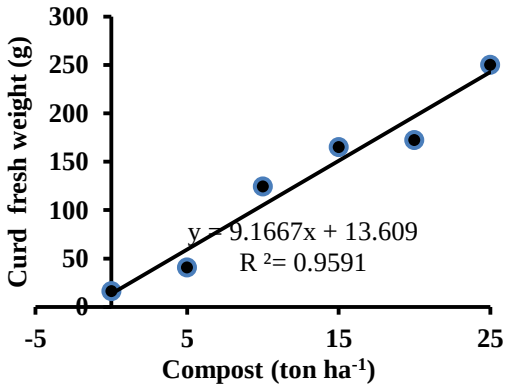

Figure 7. Curd fresh weight as affected by tithonia compost rate

Similar fashion to crop diameter, curd fresh weight also increased as tithonia compost rate increased (Figure 7). The highest curd weight was recorded from the rate of 25 ton ha^{-1} (250 g), followed by 20 ton ha^{-1} (172.5 g). Even at the low rate, tithonia compost influenced the yield of cauliflower. The

smallest yield was observed at control treatment (16.25 g). These numbers showed that tithonia compost has an important contribution to the plant growth and development.

Discussion

Organic fertilizer (OF) plays an important role in providing plant nutrients in organic farming practice. Organic fertilizer is sources of many essential and using OF with high organic matter contents (OM) can improve physical properties of soils (Barker, 2010). The soil OM serves both the long-term storage medium and as the primary short-term source of nitrogen and phosphorous and other nutrients. High levels of soil OM are associated with enhanced soil aggregation and nutrient cycling (Weil and Magdoff, 2004).

Decomposition of soil OM releases plant nutrients. This study shows that increasing tithonia compost rate followed by increasing plant height. Compost at the rate of 20 kg ha^{-1} resulted in the highest plant height (Figure 1). Increasing plant is related to the increase in organic matter from tithonia compost. A number of studies showed that soil physical and chemical properties were significantly and positively enhanced with increasing rate of tithonia compost application. Guong *et al.*, (2010) reported that tithonia amendment led to an increase in soil organic matter content, available nitrogen and phosphorous, cation exchange capacity, percentage base saturation, soil respiration, soil aggregate stability as well as reduce soil compaction. Green leaf biomass of tithonia contains 3.5% N, 0.37% P and 4.1% K on a dry matter basis (Jama *et al*., 2000). Similar to our finding, Babajide *et al*., (2008) reported that tomato plant height increased with increasing compost rate.

Similar to plant height, linear fashion was also observed in leaf number, leaf dry weight, as well as total plant dry weight (Figure 2, 3 and 4). Not only in the vegetative part, but similar trend of the influence of compost rate was also recorded in the yield of cauliflower. Curd diameter and weight increased with increasing the rate of compost (Figure 6 and 7). Babajide (2008) reported that increasing compost rate was also increased plant height, leaf area, numbers of branches, tap-root length and fruit yield.

Tithonia compost affects plant dry weight, curd diameter and curd weight linearly (Figure 4, 6 and 7). The highest plant dry weight, curd diameter, and curd dry weight was recorded at the rate of 25 ton ha^{-1}. This result might be associated with the tithonia nutrient content and the physical change of soils. Hafifah *et al.* (2016) concluded that application of tithonia green manure could significantly decrease bulk density, increase organic carbon, total N, available P, as well as exchangeable K. Tithonia, can substitute for urea as N sources (Opala *et al*., 2015) and as complement of inorganic fertilizers in Kales

(Mwangi and Mathenge, 2014). Aghofack-Nguemezi and Dzukam (2016) reported that extracts and powders of tithonia improved tomato growth and yield and foliar application of tithonia increased pechay plant weight and height (Pena *et al.*, 2013).

Tithonia compost enhances time of flowering (Figure 5). This finding could be associated with the contribution of P to the soil. Shokalu *et al.* (2010) reported that application of tithonia had a significant effect of P-content of soil. Muktamar *et al.* (2017) also reported that tithonia liquid organic fertilizer improved soil quality and plant nutrient supply. P-content of tithonia was 0.87% as reported by (Fahrurrozi *et al.*, 2017), 0.37% (Jama *et al.*, 2000). Phosphorus stimulates root development to get nutrients from the soil as well as responsible for crop maturity.

In summary, tithonia compost affects cauliflower growth and yield. Increasing the rate of compost is followed by an increase in plant height, plant dry weight, curd diameter, as well as curd weight. Compost of tithonia also accelerates the time of flowering. Our results indicate that tithonia compost can substitute synthetic fertilizer in a closed organic farming system.

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