INNSPUB

International Journal of Agronomy and Agricultural Research (IJAAR)
ISSN: 2223-7054 (Print) 2225-3610 (Online)
http://www.innspub.net
Vol. 11, No. 5, p. 30-36, 2017

RESEARCH PAPER

OPEN ACCESS

Potential utilization of guava leaves and neem seeds extraction waste as organic compost fertilizer in Temulawak (*Curcuma xanthorrhiza* Roxb.) cultivation

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Article published on November 30, 2017

Key words: Temulawak, Compost, Guava leaves, Neem seeds, Industrial waste

Abstract

Temulawak (*Curcuma xanthorrhiza* Roxb.) is a native Indonesian herbal medicine that has well used as traditional remedies to treat various diseases. However, productivity aspect which is important to sustain temulawak availability and quality seems to be neglected. In order to obtain the highest output in term of quality and quantity, not only a temulawak seed with best quality is required but also the fertilization process becomes crucial during cultivation. The aim of this research is to explore the benefit of using industrial organic waste material as an organic fertilizer in temulawak cultivation. The waste of guava leaves and neem seeds extracts are use in this study since both of them are well known to rich with minerals and nutrients that are important to fertilize soil. Three separate conditions were applied for the fertilization process, one with guava leaves extract waste, one with neem seeds extract waste and the other one with manure as the control. The results showed that compost from guava leaves extract waste gives positive benefit more for vegetative growth, while compost from neem seeds extract waste gives a better result for rhizome formation. Guava leaves and neem seeds waste gives more positive result at certain parameter of measurement than manure, although statistical significance is failed to be obtained. It can be concluded that guava leaves and neem seeds extracts waste is still valuable and can be utilized as organic fertilizer.

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Introduction

Temulawak (*Curcuma xanthorrhiza* Roxb.) or Javanese Turmeric -one of a native Indonesian herbal medicine, is a member of the ginger family *(Zingiberaceae)*. Temulawak, in which the utilized part is its rhizome, has been use as traditional remedies to treat various diseases as antiinflammation (Jacob, 2007), antioxidants (Kumar *et al.,* 2007), anticancer (Thangapazham *et al.,* 2008), antimicrobial (Goel, 2008), and hepatoprotective (Farombi, 2008).

Temulawak can be cultivated in almost throughout Indonesia, especially in Java. Besides in Indonesia, this plant is commonly cultivated too in Malaysia, Philippines, Thailand and India (Sumiwi and Sidik, 2008).

Optimal growth conditions for temulawak are 100-600m above sea level with soil that has good drainage, medium solum, a texture ranging from clay to sandy loam and a loose consistency. Temulawak is a perennial plant that takes approximately 9-12 months to harvest (Rahardjo, 2010). There are several aspects that may play an important role in temulawak cultivation, and fertilization is one of them. In order to have a suitable and fertile soil for cultivation, there are two types of fertilization approach can be used, one by applying an inorganic (chemical) fertilizer, and the other one by using an organic fertilizer. Organic fertilizer is a fertilizer derived from organic materials that are decomposed by microbes, of which the outcome can provide nutrients needed for plant growth and development. The use of organic fertilizer becomes more preferable to use than an inorganic due to safety and environmental issue. The common material used in organic fertilizer are manure, rice husk, compost, city waste, etc. (Simanungkalit, 2006).

Nowadays, industrial waste becomes an environmental concern due to its potential pollution. Therefore, efforts are needed to be made for controlling pollution by conversion of these unwanted waste into utilisable materials for various beneficial uses. Extraction wastes from parts of plant are often regarded unuseful, worthless and to some extend has a potential environmental pollution.

In Asia, guava *(Psidium guajava* L.) leaves extract is used traditionally to treat diarrhea and gastrointestinal disturbance (Ramalingum, 2014). However, the leaves waste after the extraction process is neglected and has not been re-utilized any further. Similar condition is also applied for neem (*Azadirachta indica*) seed. Neem seed as a source of neem oil are widely used in Ayurvedic traditional medicine to treat acne, fever, leprosy, malaria, ophthalmia and tuberculosis. The waste of pressed seeds of the neem is often left unuse and untreated, where actually extraction waste like guava leaves and neem seeds contain a potential source for compost.

Compost of neem has been used as fertilizer and pesticide for eggplant cultivation and showed a significant beneficial impact on plant growth (Gajalakshmi, 2004). However, the effect is still unknown if the neem compost is applied to rhizomatous herbaceous perennial plant, such as temulawak. It is interesting to further investigate the effect of neem compost and guava leaves to temulawak cultivation.

Therefore, the aim of this research is to investigate the possible benefit of using industrial organic waste material such as guava leaves and neem seed as an organic fertilizer in temulawak cultivation. It is expected that the use of those organic waste could give positive impact for temulawak production in similar manner or even show its superiority in compare with other organic fertilizer such as manure. Conversion of guava leaves and neem seed waste into an organic fertilizer can be a promising approach for controlling environmental pollution.

Materials and methods

Study Area and Experimental Design

The research was carried out in SOHO Center of Excellence in Herbal Research (SCEHR) located in Cihanjawar Village, Nagrak, Sukabumi, West Java on January-September, 2016. Temulawak seed Cursina 2 is variety seed used in cultivation study. The land used for this research was 225 m^2 with 50 x 50 cm planting distance.

Common farming equipment from local farmers were used during the cultivation. Three separate conditions were applied for the fertilization process, one with guava leaves extract waste, one with neem seeds extract waste and the other one with manure as the control. The compost of guava leaves and neem seeds, which were used in this research, were obtained subsequently from PT SOHO Industri Pharmasi and Eco Learning Camp Foundation.

The fertilization conditions were performed in triplicate, with manure, neem seeds compost, and guava leaves compost for each replication. The number of plants per replication was 100 plants per each condition (Table 1). The manure or composts starts to be administered 2 weeks before planting in each hole for 3 times within those periods. Total amount of manure or composts used for fertilization process was corresponded to the previous study by Rahardjo (2010), which is 2 kg/hole in those 3 times.

Table 1. Fertilization design for manure, neem seed compost and guava leaves compost.

Area of Replication 1 (n=300)	Area of Replication 2 (n=300)	Area of Replication 3 (n=300)
Manure (n=100) Neem Seeds (n=100) Guava Leaves(n=100)	Manure (n=100) Neem Seeds (n=100) Guava Leaves (n=100)	Manure (n=100) Neem Seeds (n=100) Guava Leaves (n=100)

The Measurement of Growth Plant

The measured parameters are agronomy characters and morphology of temulawak, which are number of tillers, plants height, number of leaves, leaves length, leaves width, and stem diameter.

Those measurements were conducted each month for 5 consecutive months until the plant reach maximum growth before it turns senescence. At time of harvest or 9 months after plantation, the agronomy characters which are including the fresh and dry rhizome weight and amount of rhizome ramification (main, branch, and twig) (Fig. 1) were measured. The weight of rhizome and its ramification are commonly used to indicate plant productivity.

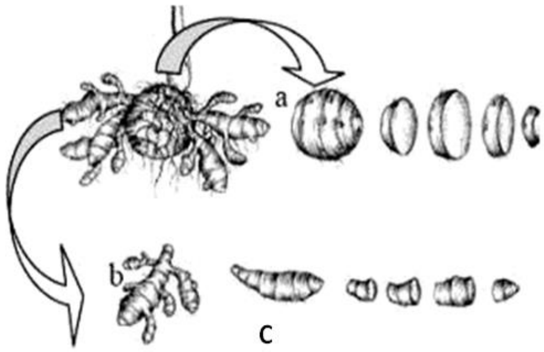


Fig. 1. The ramification of temulawak rhizome. A.) Main rhizome; B) Branch rhizome; C) Twig rhizome.

Results

The agronomy measurement results on temulawak growth at aged 1 to 5 months treated with either manure, or guava leaves compost or neem seed compost were shown in Table 2. Although almost none of the measured parameter from those three different conditions were able to reach statistical significance, the plant height measurement shows that guava leaves compost treatment group gives a better result with 33.87-114.33cm followed by neem seed compost treatment group with 39.33-108.53cm in compare with manure as control with 34.47-88.20cm.

Similar pattern also observed from plant diameter measurement, in which the biggest stem diameter was obtained from guava leaves compost treatment group (4.50-14.40mm) followed by neem leaves compost treatment group (6.97-11.17mm) in compare with manure as control (4.50-7.17mm). The stem diameter difference between the compost treatment group and control is statistically significant. The measurement of leaves lenght and width show that the leaves are slightly longer and wider in compost treatment groups in compare with control, while the other measured parameters such as number of leaves, and number of tillers did not show any different between compost treatment groups with control group.

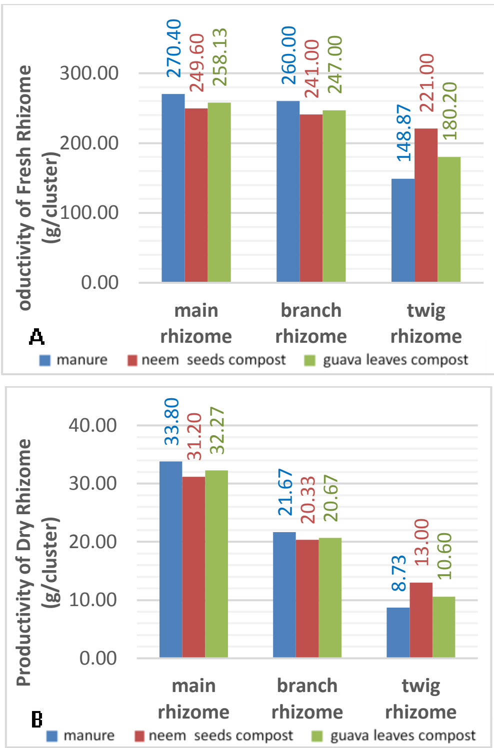
Productivity of temulawak based on rhizome weight and its ramification from both fresh and dry rhizome were shown in Graph 1. There are no statistically significant difference between 2 groups of compost treatment with control. Interestingly that the twig rhizome from neem seeds compost treated group yields the highest weight among all other treatment groups.

This was confirmed by the results from total fresh rhizome (main, branch, and twig) weight measurement. Total weight of rhizome from neem seeds compost was the heaviest with 714.60g per cluster, whereas from guava leaves compost was 685.33g per cluster and from manure was 678.87g per cluster.

Table 2. The measured agronomy characters and morphology of temulawak from each fertilization treatment group at aged 1-5 months after planting**.**

Treatment	Months after planting					Months after planting				
	1	2	3	4	5	1	2	3	4	5
	Plant Height (cm)					Leaves Length (cm)				
Manure	34.47 a	50.4 b	64.6 a	87.6 a	88.2 a	17.20 a	27.53 a	48.67 a	40.70 a	40.50 a
Neem compost	39.33 a	71.53 a	84.93 a	107.93 a	108.53 a	21.60 a	37.00 a	44.93 a	49.73 a	49.53 a
Guava compost	33.87 a	58.13 b	90.73 a	113.73 a	114.33 a	19.27 a	31.07 b	48.67 a	53.47 a	53.27 a
CV (%)	21.4	7.25	17.67	13.73	13.65	19.76	5.09	12.55	11.29	11.34
	Stem Diameter (mm)					Leaves Width (cm)				
Manure	4.50 b	7.30 b	8.67 b	9.67 b	7.17 b	7.07 a	10.07 b	12.00 a	11.40 a	10.30 a
Neem compost	6.97 a	10.17 a	12.67 a	13.67 a	11.17 a	8.87 a	13.20 a	14.33 a	13.73 a	12.63 a
Guava compost	4.50 b	6.60 b	15.90 a	16.90 a	14.40 a	7.73 a	11.13 b	15.20 a	14.60 a	13.50 a
CV (%)	15.57	17.32	13.85	12.82	15.76	16.1	6.81	10.66	11.14	12.15
	Number of Leaves (sheet)					Number of Tillers				
Manure	3.73 a	5.00 a	5.77 a	5.87 a	4.90 a	0.33 a	1.00 a	1.17 a	1.87 a	1.97 a
Neem compost	3.53 a	5.67 a	6.20 a	6.30 a	5.10 a	0.67 a	1.10 a	1.53 a	2.23 a	2.33 a
Guava compost	3.73 a	5.00 a	6.00 a	6.10 a	4.90 a	0.03 a	0.67 a	0.77 a	1.23 a	1.30 a
CV (%)	14.76	7.44	6.56	6.45	8.04	129.9	37.74	42.1	38.56	38.34

Numbers followed by same letters in the same column indicate insignificant difference based on Least Significant Difference (LSD) Test at α=0,05.



Graph 1. Productivity of fresh rhizome (A) and dry rhizome (B) per cluster of temulawak from various fertilizer treatment at harvest.*Significantly different with α=0,05 based on Least Significant Difference test.

Discussion

In general, all plants including temulawak, require nutrients to grow and have a good productivity. The required nutrient mostly come from its availability in the soil where the cultivation done. In order to provide a sustainable nutrient in the soil, fertilization could be the best approach. However, the use of inorganic fertilizer in large scale raise some concern regarding its safety and environmental issue. Therefore, the use of organic compost as the fertilizer becomes more demanding.

Many research regarding the use of compost start to gain more interest. Compost could be derived from various part of plant through decomposing process. The composting process can be defined as biochemical process, where many kind of microorganisms decompose organic materials and turn it into humus, which has the same properties as manure (Gaur, 1982). Industrial organic waste after extraction could offer a promising approach for a new source of compost while giving the waste an added value. Neem seeds and guava leaves waste were used due to their rich of nutient and component required by temulawak.

Neem seeds waste is considered to be a suitable candidate for an organic compost since it can help to increase the nitrogen and phosporous content in the soil (Lokanadhan *et al.*, 2012). Nitrogen (N), phosphorus (P) and potassium (K) are three components in the soil that are crucial for temulawak's rhizome growth (Nihayati *et al.*, 2013).

Guava leaves also consist N, P and K at certain level depend on the leaves age (Singh and Rajput, 1978) and the amount of N, P, K loss during the extraction process. However, despite those potential mineral loss during the extraction, the organic waste still consist some amount of N, P, K that can beneficially for temulawak plantation process. Leaves compost also improves soil structure and texture, which then lead to a better availability of nutrients, moisture, and air for plants.

The agronomy measurement conclude that both guava leaves and neem seed waste compost gave a better effect on vegetative growth parameter such as plant height, stem diameter, and leaves length and width, in compare to manure as control. Guava leaves are rich with nitrogen, phosphorus, and potassium, although the concentration is depending on month of growth (Singh and Rajput, 1978; Nautiyal, *et al.*, 2016) substantiate the result that guava leaves compost gives the best temulawak growth. Neem seed is also rich of nitrogen and phosphorus to give additional supply to the soil.

It is well known that to produce high quality plant, just as important as water and sunlight, nitrogen (N) content in the soil is also critical for the vegetative growth (Vince, 2001).

The lack of nitrogen are tightly linked for causing plant dwarfness. The better vegetative growth in groups of compost could be the result of nitrogen fulfillment from compost (Junita *et al.*, 2012). It is also supported by the fact that compost may contents more nitrogen than manure (Jones, 2006). Furthermore, Phosphorus (P) is needed to increased shoot growth under water deficit (Divito and Sadras, 2014), while temulawak is usually growth throughout the dry seasons.

This explains our finding that the best result on plant height and stem diameter was obtained from guava leaves waste compost group followed by neem seed waste group. Another mineral containing compost that also play an important role to the results is Potassium (K). Potassium is involved in enzyme activation, protein synthesis, photosynthesis, osmoregulation, stomatal movement, energy transfer, phloem transport, cation-anion balance and stress resistance (Wang, *et al.*, 2013).

Rhizome productivity is the main yield of temulawak cultivation system. Rhizome is a plant storage place to keep photosynthesis product. There are some components which are crucial for photosynthesis process and their availability become highly needed. These component are, water (During and Dry, 1995), carbondioxide (Debona, *et al.*, 2014), light (Li, et.al., 2014), nutrient for a building block (Fan, *et al.*, 2014), and chlorophyll (Chen, 2014). The application of fertilizer ensure that plants will have enough building blocks to enter photosynthesis process. Nonetheless, compost fertilizer may provide more nutrient that could add an extra building blocks for plant photosynthesis. The amount of light and chlorophyll also play an important role for the photosynthesis process, supporting the facts that plant with longer and wider leaves produce a heavier rhizome. The neem seed compost treatment produce a temulawak plant with longer and wider leaves, which gives an inline result with the productivity measurement where temulawak with neem seed compost has the heaviest rhizome.

Taking all the results into account, compost fertilizers from guava leaves and neem seeds waste are potent to improve temulawak vegetative growth and productivity, respectively.

Since the results from the aforementioned conditions are failed to reach statistical significant differences with control, further research regarding the effective dosage are required. Even though currently there is no available data about the optimal amount of compost fertilizer for temulawak plantation, application of the correspond amount for *Curcuma longa* which is 30-40 tons/ha could be the first approach for further investigation (Jayashree, 2011).

Conclusion

Compost from guava leaves extract waste gives positive benefit more for vegetative growth, while compost from neem seeds extract waste gives a better result for rhizome formation. In spite of the fact that statistical significance is failed to be obtained, compost treatment gives more positive result at certain parameter of measurement than manure treatment. It is concluded that guava leaves and neem seed extracts waste is still valuable and has a potential to be utilized as organic fertilizer.

Acknowledgement

The authors appreciate Eco-Camp Foundation that kindly provided sample of neem seed as a composition of compost which has been applied for the research.

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