Research article

Study on Suitable Moisture for Pellet Compost Making and Machanical Mixing Technique

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Abstract Pellet compost contributes to sustainable agriculture systems in Cambodia. It also inspires Cambodian farmers to use organic fertilizers instead of chemical fertilizers in agricultural practices. According to the sustainable agriculture program for environment conservation of the Institute of Environment Rehabilitation and Conservation (ERECON), one topic for study concerns machine and mixing techniques with suitable moisture for making pellet compost. The purposes of the experiment are to study about the process of making pellet compost with two kinds of machines (diskpelleters and mincing machines), and to identify appropriate moisture for practical use of each machine. There are some parameters for studying the process of making pellet compost of those machines, such as potential of each machine, percentage of good pellet compost, length of the granule, and characteristics of the granule. In identifying moisture, five treatments and three replications were selected, each of which was added with different amounts of water: T1= 750 ml, T2= 900 ml, T3= 1050 ml, T4= 1200 ml, and T5= 1350 ml into 5.505 kg of compost mixture compound with 23.36% of water content, which consists of conventional compost, termite-mound soil and palm sugar with a ratio of 5:0.5:0.005. As a result, for the diskpelleter machine experiment, we got the best result for treatment T2 which was added with 900 ml of water and had 45.42% of water content. The producing capacity of this machine was 139.75 kg/h in dry mass. For mincing machine, treatment T3, added with 1050 ml of water and having 48.69% of water content, got the best result, with a producing capacity of 64.39 kg/h in dry mass. Therefore, 45.42% of water content in compost mixture was the best moisture for making pellet compost with the diskpelleter machine and 48.69% of water content in compost mixture was the best moisture for making pellet compost with the mincing machine.

Keywords: conventional compost, termite-mound soil, pellet compost, water content.

INTRODUCTION

Pellet compost making is an activity that contributes to the sustainable agriculture system in all agricultural countries, especially in developing countries like Cambodia. Currently, soil degradation has been widespread around the world due to agricultural practices depending on chemical fertilizer only. Therefore, it should be improved from the viewpoint of soil nutrient substance. Pellet compost combined with conventional compost, soil, and molasses at the ratio of 10:1:0.01 by adding some amount of water has been used for sustainable agriculture (Mihara, M. and Akimi, F., 2007). According to Mihara et al., (2005) adding 0.01 unit of molasses with moisture is suitable for crop growing, but if molasses is added in higher amount, the crop growth is reduced and has a shorter life than when normal fertilizer is applied. The compost pellet size produced by mincing machine was 0.5 cm in diameter and 1 cm in length with the same ratio above mentioned (Siriwattananon, L. and Mihara, M., 2008). There are many kinds of plant residues for making conventional compost such as rice straws, sugar cane leaves, corn trees, grasses or leaves, bean residues, saw dust, bean trees and animal manure that can be used as raw materials (Mihara, M. and Akimi F., 2007). According to CEDAC (2008) there are several composting materials such as liquid bio-fertilizer, chicken manure, bat manure, palm sugar, hill soil, surface soil, ash, and bean residues at the ratio of 50:50:5:3:100:100:50:5, respectively. Moisture determination of compost mixture was very important for Extruder machines and Diskpelleter machines. Moisture of compost mixture has a strong effect on compost cohesion and on the speed of pellet compost process. The suitable moisture for Extruder machine was from 35% to 45% and from 25% to 35% for diskpelleter machine (Hara, 2001). Furthermore, conventional compost is very important for making pellet compost, so we should make sure that it does not contain hard waste and stones that can damage the machine, thus requiring more spending on machine repair. Pellet compost is used as an organic fertilizer and its production is expensive because it should be produced with high quality standards, and nutrient substances (Hara, 2001). Advantages of pellet compost include the ompost's bulk density, being for conventional compost 1.9g/cm^3, that is, less than soil bulk density which is 2.7g/cm^3, so whenever rainfall or surface runoff water occurred, conventional compost could be washed out easily. On the other hand, pellet compost stays in the soil and prevents soil nutrient erosion, is very effective and it is easy for transporting (Mihara, M. and Akimi, F., 2009). Pellet compost can be used on any kind of crops that will grow well and produce high yield. Moreover, it does not have an impact on human health and it is economical, and so farmers can earn money from selling pellet compost (CEDAC, 2008). Therefore, the objectives of the research are to study the process of making pellet compost with two kinds of machines (diskpelleter and mincing machines), and to identify an appropriate moisture for practical purposes with each machine.

MATERIALS AND METHODS

The research was carried out at the Royal University of Agriculture and it is focused on two purposes: the processes of making pellet compost with two kinds of machines, and the suitable moisture of compost mixture for each machine. The materials for this research are: mixture machine, two pellet compost machines, oven machine, conventional compost, termite-mound soil, palm sugar and water. According to Hara (2001), the process of making pellet compost has eight steps, which are: composting, mixture agitator, mechanized sieve, molding machine, dryer, mechanized packaging in bags, distribution and storage, and this method was used in the present research. Diskpelleter machine and mincing machine were used for making pellet compost combined with conventional compost, termite-mound soil, and palm sugar in the ratio of 5:0.5:0.005. In order to determine the suitable moisture of compost mixture, 5 treatments were defined and each treatment contained 5.505kg of compost mixture compound added with 5 different levels of water; T1: 750 mm, T2: 900 mm, T3: 1050 mm, T4: 1200 mm, and T5: 1350 mm. Moreover, replications for producing pellet compost of each treatment were completed three times, as R1, R2, and R3. Data of experiment were collected, such as moisture of compost mixture

by selecting sample and putting it in oven machine, potential of each machine by weighing total compost pellet product with timing during making, compost pellet length by measuring in meters and good pellet compost by separating good and broken compost pellet. Furthermore, according to Chrun Rithy (2009), the water content of compost mixture in dry mass was calculated by the Eq.(1) (Norman, 1987).

$$Md = Ww / Wd \times 100 \quad (1)$$

where, Md is the moisture content, d.b. (%), Ww is the weight of water (g) and Wd is the weight of dry sample (g).

Several software programs were used to analyze all data, based on objectives of the present study. Those programs were Microsoft Excel and SPSS 15 used to compare the significant difference of 5% for the treatments by analyzing a variance of one-way ANOVA and LSD.

RESULTS AND DISCUSSION

The pellet compost making processes

The pellet composting process was considered, each stage being done in order and all materials prepared for pellet composting. There are seven stages of making pellet compost by using diskpelleter machine and mancing machine, as shown in Fig. 1

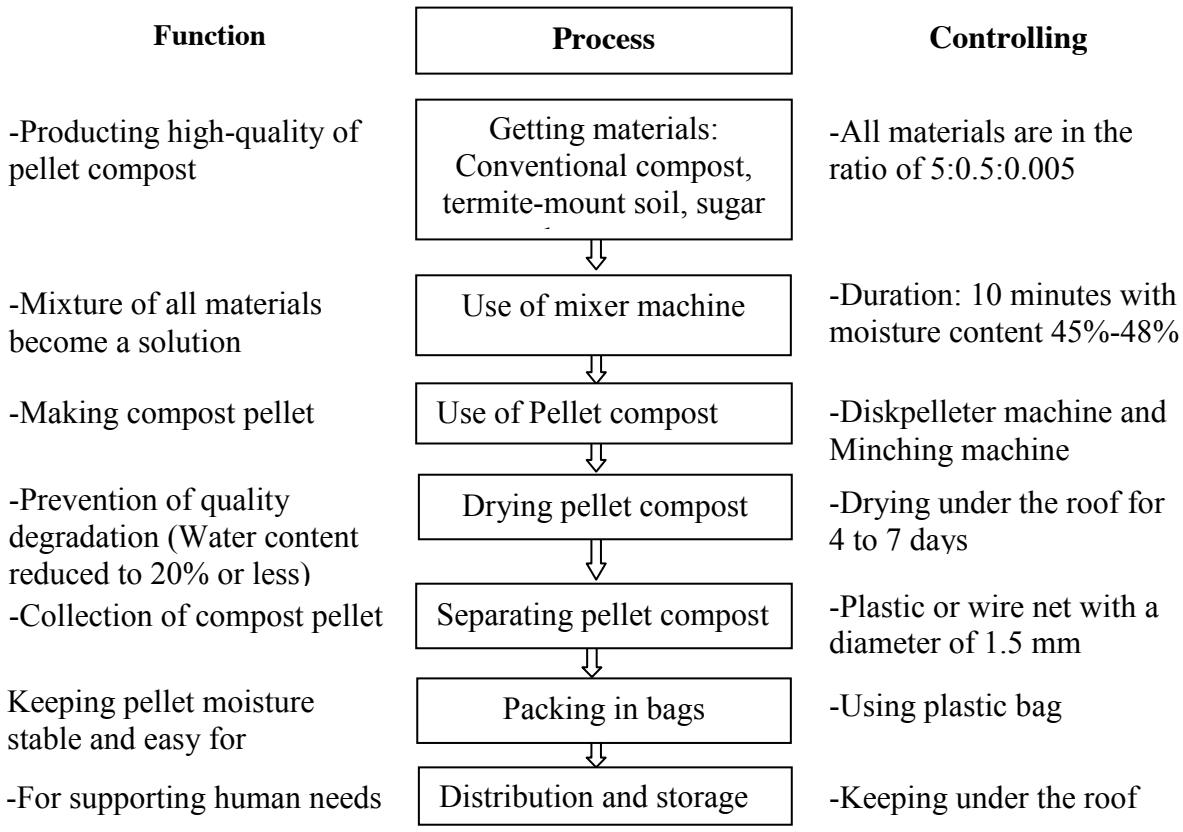

Fig. 1 Process for making pellet compost

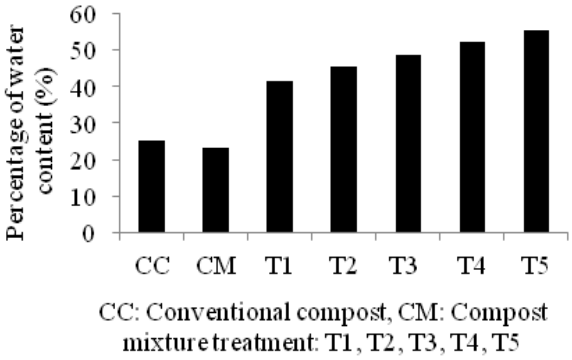

Fig. 2 Moisture of compost mixture (%)

Firstly, materials for making pellet compost include conventional compost, termite-mound soil, and sugar were mixed at the ratio of 5:0.5:0.005 by adding a suitable water amount. We had to make sure that the conventional compost and termite-mound were in good condition. Secondly, all materials were mixed by mixer machine until it became a fine mixture, for about 10 minutes. Thirdly, the compost pellet was produced by the diskpelleter machine and the mincing machine. In this stage, compost mixture with suitable moisture was put into the machines, resulting in the production of pellet compost. Fourthly, after producing pellet compost, this was dried under the roof around 4 to 7 days so its water content could be reduced to 20% or less, being this a suitable moisture for storage (Hara, 2001). When drying pellets, some of them were cracked, and so it was necessary to separate them by sacking with a plastic net. Then, pellet compost was packed in plastic bags in order to keep stable moisture. Finally, pellet compost was distributed and stored under a roof or cool place. The results of the moisture of compost mixture (Fig. 2) showed that water content of conventional compost (CC) was 25.34%. After being mixed with termite-mound soil and sugar, the water content of compost mixture (CM) was reduced to 23.36%. The treatment T1 was to add 750 ml of water on 5.505 kg of compost mixture compound, and its water content increased to 41.65%. 150 ml of water was added, increasing from one treatment to another: T2, T3, T4, and T5 and water content increased to 45.42%, 48.69%, 52.28%, and 55.49% respectively.

The potential of diskpellet machine for producing pellet compost

According to the results in Fig. 3, the potential of treatments using the diskpelleter machine decreased while water content increased in T1, T2, T3, T4, and T5. The highest potential of this machine was T1: 49.96 g/s or 180 kg/h in dry mass, that had a higher significant difference than the other treatments ($P<0.05$). The lowest potential was T5: 25.01 g/s or 90 kg/h in dry mass. In contrast, even though the treatment T1 had the highest potential value, the compost pellet was a little bit dry, and so it was easy to be cracked. Furthermore, the good compost pellet after sacking it is not different to those of T2 and T3 with a significant difference level of $P>0.05$ (Fig.4). The results of the experiment in Fig. 5 show that the length of compost pellet is not significant among treatments ($P>0.05$). The longest compost pellet length from diskpelleter machine was in treatment T5: 11.24 mm and the shortest was in treatment T1: 8.93 mm; these compost pellets were 5 mm in diameter.

A survey was applied to 20 people to evaluate moisture and length of pellet compost for each treatment. Scores ranged from one to five, with one being very bad to five being very good. Fig. 6 shows that the most popular treatment was T2: 3.65 marks for pellet moisture and 3.7 marks for pellet length. Therefore, the best treatment was T2: 45.42% of moisture and 9.43 mm of compost pellet length using the diskpelleter machine

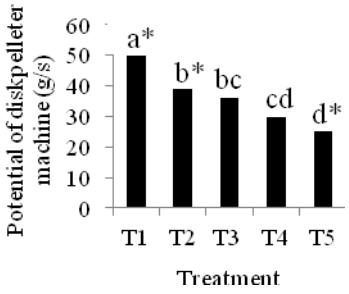

Fig. 3 Potential of diskpelleter machine (g/s)

** Significant difference at P<0.05*

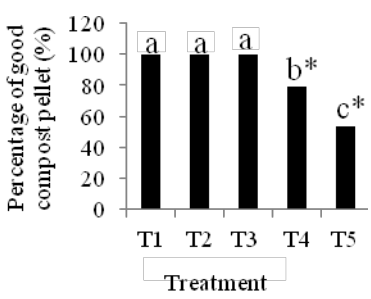

Fig. 4 Percentage of good compost pellet (%)

** P<0.05*

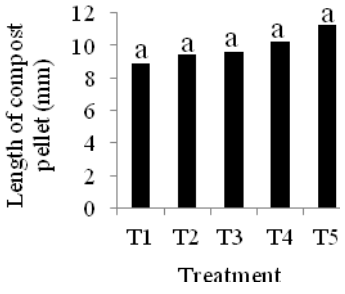

Fig. 5 Length of compost from diskpelleter machine (mm)

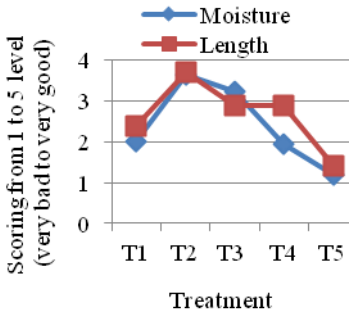

Fig. 6 Suitable characteristic of compost pellet

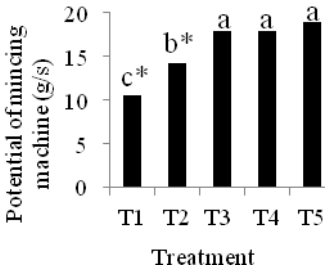

Fig. 7 Potential of mincing machine (g/s)

** Significant difference at P<0.05*

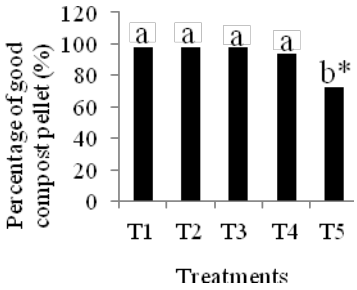

Fig. 8 Percentage of good compost pellets (%)

** P<0.05*

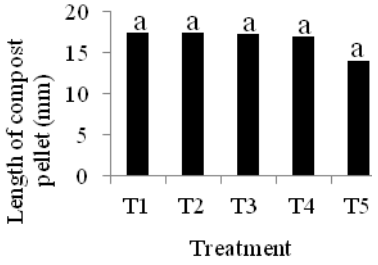

Fig. 9 Length of compost pellet from Mincing machine (mm)

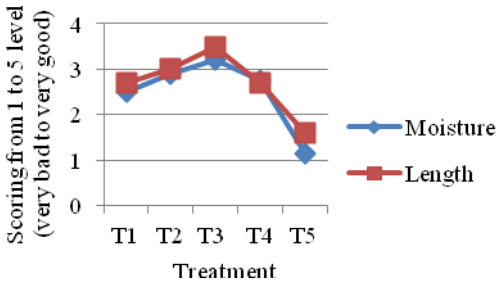

Fig. 10 Suitable characteristic of compost pellet

The potential of the mincing machine for making pellet compost

According to the results in Fig. 7, the potential of treatments using the mincing machine increased, when water content increased in T1, T2, T3, T4, and T5. The highest potential of this machine was in T5: 18.88 g/s or 68 kg/h in dry mass and it was not significantly different to treatments T3 and T4 (P>0.05). The lowest potential was T1: 10.5 g/s or 37.8 kg/h in dry mass. In contrast, even though the treatment T5 presented the highest value, the compost pellet was too wet, and so it stuck together and became a big aggregate. The good compost pellet after being separated had a significant difference to other treatments with a significant level of P<0.05 (Fig. 8). The results of the experiment in. Fig. 9 show that the length of compost pellets was non-significant among treatments (P>0.05). The longest compost pellet length was in treatment T1: 17.52 mm and the shortest was in treatment T5: 14.07 mm. Those compost pellets were 5 mm in diameter. A survey

was applied to 20 people to evaluate moisture and length of compost pellets for each treatment. Scores ranged from one to five, with one being very bad to five being very good. Fig. 10 shows that the most popular treatment was T3: 3.2 marks for pellet moisture and 3.5 marks for pellet length. Therefore, the best treatment was T3: 48.69% of moisture and 17.33 mm of compost pellet length with the mincing machine.

Discussion

According to Hara (2001), the most suitable moisture of compost mixture was 35% to 45% for the Extruder machine and 25%-35% for the Diskpelleter machine. However, the most suitable moisture of compost mixture in this research was 48.69% of water content for the mincing machine. In addition, the water content of compost mixture from 45.42% to 52.28% could be applied with this machine, while 45.42% of water content of compost mixture was the most suitable for making compost pellet by the diskpelleter machine. Moreover, the water content of compost mixture from 41.65% to 48.69% could be applied with this machine, too.

CONCLUSION

Based on the results of this research, it can be concluded that the diskpelleter pellet compost machine has potential to produce pellet compost from 90 kg to 180 kg per hour, while the mincing machine can produce from 37 kg to 68 kg per hour. According to the results of LSD analysis and survey on 20 people about compost pellet characteristics (moisture and length) the optimal choice when using the diskpelleter machine is treatment T2 added with 900 ml of water on 5.505 kg of compost mixture with 23.36%, being the water content of compost mixture after adding water 45.42%. For the mincing machine treatment T3 was the most suitable, which was added with 1050 mm of water on 5.505 kg of compost mixture, and the water content of compost mixture after adding water was 47.69%.

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