Novelty Journals

ISSN 2394-9716

International Journal of Novel Research in Interdisciplinary Studies
Vol. 2, Issue 5, pp: (1-6), Month: September-October 2015, Available at: www.noveltyjournals.com

Intensifying Fortified Compost Pellets: A New Farming Management Option in Kalinga

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Abstract: **This study emanated from the problems encountered by the author appurtenant to the implementation the vermicompost production project at Kalinga-Apayao State College, Cordillera Administrative Region, Philippines. As noted from the project, farmer-beneficiaries usually make their organic fertilizer after establishing their crops and stock them for use in the next cropping season. However, these organic fertilizers became very dry when they were needed. To facilitate the application of these organic fertilizers, re-wetting and re-packing were done resulting to multiple handling with added cost. Thus intensifying fortified compost pellets as a new farming management option in Kalinga was undertaken.**

This study was centered on the influence of pelleting on the growth of beneficial microbes. Two compost substrates with three replications were tested using a designed machine fabricated by Imatong et al, 2012. The substrates were; C_1 – vermicompost supplemented with urea and complete fertilizer (14-14-14) and C_2 – plain commercial organic fertilizer. Both treatments received the same amount of 453.6 ml of microbial solution at 2.5% concentration of molasses. Statistical t–test was used to compare the results.

Results of the performance test showed that the machine produced fortified pellets with a mean bulk density of 889.92 kg/m^3. The volume of pelleted compost was reduced to about 65% of its original volume. The growth of compost bacteria was evident in unpelleted samples compared to pelleted ones 12 hours after incubation while the growth of compost fungi was only noticed 36 hours from incubation. Substrate C_1 was greatly influenced by pelleting as manifested by a microbial survival rate of 17.5% while the fungal colony registered a survival rate of 33%. Likewise, substrate C_2 gave a bacterial survival rate of 44% after pelleting. The fungal colony of substrate C_2 registered a survival rate of 87.22% after pelleting.

Keywords: **Fortified organic fertilizer pellets, pellet density, colony-forming units (CFU).**

I. TECHNICAL REPORT

RATIONALE:

Organic fertilizer is any decomposed material of plant and animal origin or its combination thereof that supplies plants with the necessary amount of nutrients for its growth and optimum yield. In the parlance of improving crop harvest, optimization of fertilizer use is an integral part of the overall crop management strategies toward realizing higher yield. Increased use of fertilizer particularly nitrogen (N) in agricultural production has raised environmental concerns. This is because the N surplus is at risk of leaving the plant-soil system due to its high volatility thereby causing ecological contamination. According to Nagy (2000), each kilogram of manufactured nitrogen-rich fertilizer releases the equivalent of 4.1 kg of CO2 into the atmosphere which appreciably contributes to global Greenhouse Gas emissions (GHG).

On the other hand, the use of vermicompost and other organic fertilizer and its production are now being practiced on a larger scale among farmers. They usually make their organic fertilizer after establishing their crops and stock them for use

in the next cropping season. However, these organic fertilizers especially those that were not lined with polyethylene bag became very dry when they were needed. To facilitate the application of these organic fertilizers in the field, re-wetting and re-packing were done resulting to multiple handling and brings added cost. Thus, other fertilizer management option such as pelleting was sought. Mineral fertilizers may be used more efficiently by crops growing on soils with adequate amounts of soil organic matter supplied by organic fertilizers (Tambanengwe and Kosina, 2007). Application of organic manure in combination with chemical fertilizer increases absorption of N, P and K in sugarcane leaf tissue in the plant and ratoon crop, compared to chemical fertilizer alone (Bokhtiar and Sakurai, 2005).

Although the pelleted organic fertilizer is relatively new in the market, this technology is fast becoming more superior and preferred organic fertilizer above liquid and powder (www.natural-fertilizer.com). This is due to the fact that pelleted organic fertilizers are much cheaper in comparison to foliar liquid organic fertilizers and the powdered teabag forms. The pelleted organic fertilizer also has the capability of slow-release. This slow-release property allows them to gradually release necessary nutrients into the soil, which allow the plants sufficient time to absorb and use them extensively throughout the growing season. The pelleted organic fertilizer also assists in the prevention of leaching, which is a common side-effect of liquid-based fertilizers, along with soil erosion. Furthermore, the volume of pellets is only 50 - 80% of the original volume of compost prior to pelleting (Hara, 1998). By compressing the pellets and reducing their volume, the pellets become better suited to transport over long distances. Another benefit is that the compactness of the pellet requires less storage space during the off season. In contrary, due to its being organic-based, the pelleted organic fertilizer contains only minor amount of chemicals. It is referred to as minor because no commercially produced pelleted organic fertilizer can be one hundred percent natural (Bokhtiar et al 2005).

II. OBJECTIVES OF THE STUDY

Generally, this study aimed to test the influence of pelleting two compost substrates using a designed machine. Specifically, it aimed to:

1. Determine the density of compost pellets
2. Evaluate the survival rate of compost bacteria and fungi as affected by pelleting

III. PROCEDURE/METHODOLOGY

Conceptual Framework:

The quality of the compost pellets as conceived in this study were influenced by several factors such as pelleting machine, fortified compost or organic fertilizer substrates, binding solution and processing method (Figure 1).

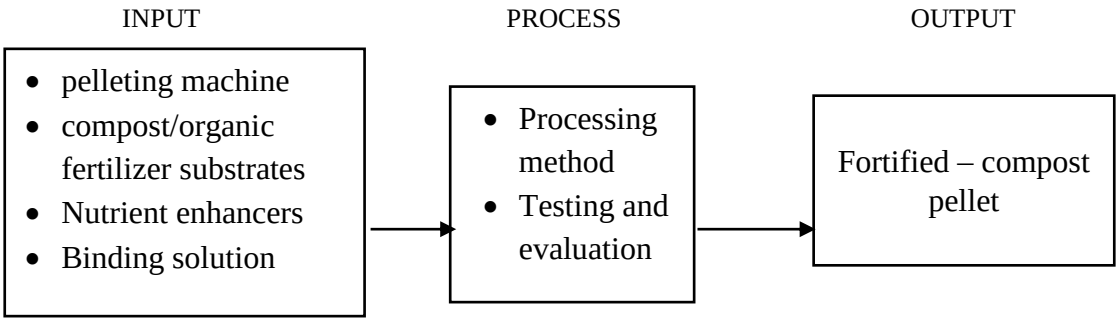

Figure 1. Conceptual framework of the study

The use of pure organic matter is not advisable due to the low nutrient content found in organic materials. Thus, nutrient enhancers must be used to boost the nutritive content of the fortified compost pellets. The drawbacks associated with chemical and organic sources of plant nutrients when considered separately are often overcome when they are used in judicious combinations (WijeWardena, 2000). Commercial strains of beneficial microbes are becoming popular. However, when used to other places, they become strange to the area; hence, problem of acclimatization usually delays their effectiveness.

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In making a fortified organic fertilizer pellets, ingredients or raw material either blended or single preparation must have been set earlier prior to pelleting. In order to assure a good quality fertilizer pellets, proper compost technology must be untaken.

Preparation of Test Materials:

In evaluating the growth of microbes in the pellets, organic fertilizer with known compost materials and a plain organic fertilizer commercially available in the market were considered as test substrate materials. These are follows:

C1 = 80% vermicompost + 20% nitrogen enhancers

C2 = plain organic fertilizer commercially available at local market

For C1, organic fertilizer was obtained from the KASC Vermi project. The amount of fortified fertilizer materials considered for pelleting was based on the current practice in the project which is 400-kg vermicompost; 50-kg nitrogenous source. The said mixture of organic and nitrogenous source was re-composted for 14 days. In C2, plain organic fertilizer that is locally available in the market was purchased and dried up to the same moisture content of 24%. No enhancer was added.

Pellet Density (PD):

The pellet density (PD) refers to the mass of compressed fertilizer mixture per unit volume. The practical application of knowing the pellet density in this study is to determine the volume reduction after pelleting a given weight of organic fertilizer. The pellet density is not a standard figure but is calibrated for the purpose of this study with 30-35% moisture content. The unit of expressing the pellet density is given in terms of kg/m3 with the working equation as;

$$PD = \frac{Mp}{v}$$

Where:

PD = Pellet density, kg/m^3

Mp = Mass of the pellet, kg

v = volume occupied by the pellet, m^3

Survival rate of Microbes Present in the Pellets

Microbial assay of a 7-day sample pellets were analyzed in the MCCTL, CAS Laboratory of Biological Sciences of CLSU. Samples of mixed substrate prior to pelleting were collected for microbial count. Two grams of each sample were taken and diluted with 4-ml of distilled water. These were subjected for fungal and bacterial enumeration expressed as cfu/ml (colony forming units per ml distilled water).

After pelleting, samples of pelletized organic fertilizer were also collected and subjected to laboratory test for microbial monitoring. Two culture media; nutrient agar, (NA) for bacteria and potato dextrose agar (PDA) for fungus were prepared. Microbial growth was done at 12 hours (for bacteria) and 36 hours (for molds) after incubation. The livability of the microbes as influenced by pelleting was based on the microbial count before and after pelleting.

Data Analysis:

Data collected during the trial test were then analyzed using t-test for comparison of means of the test materials to determine their statistical difference.

IV. SCHEDULE OF ACTIVITIES

ACTIVITIES	Jan'12				Feb			
Pelleting								
Lab analysis								
Data processing								

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V. BUDGETARY REQUIREMENTS (estimate)

Project cost:

A. Supply/materials PhP10,000

B. Documentation PhP 1,000

VI. FINDINGS

Pellet Bulk Density:

The bulk density of the substrate C_1 and C_2 before pelleting were 567.76 kg/m^3 and 561.39 kg/m^3 respectively. Table 1 revealed that the average bulk density of pellets were 889.82 kg/m^3 for C_1 and 733.97 kg/m^3 for C_2. Highly significant differences of the two means were eminent as manifested by the t-test. As part of the observation, the substrate C_2 was little bit bulky and contain more carbonized rice husks (CRH) while substrate C_1 has no rice CRH.

Table 1. Bulk density of the fortified bio-organic fertilizer pellets, kg/m^3

TRIALS	TEST MATERIALS		GRAND MEAN
	C_1	C_2	
1	893.11	733.63	
2	887.16	734.66	
3	889.19	733.63	
Mean	889.82[a]	733.97[b]	811.90

Means in a row with different letters are highly significant at 1% level of significance using t-test

Considering the prevailing application rate of 8 bags/ha (400 kg) of unpelleted vermicompost, entails a volume of 0.70 m^3. Nonetheless, if this were pelleted, it would only require a volume of 0.45 m^3. Based on the volume occupied by un-pelleted and pelleted organic fertilizer, application rate would entail a volume reduction of 35%. Hence, pelleting the eight (8) bags of vermicompost prior to application would be only 5.2 bags of the same mass. This would save volume required for handling and storing of the same amount of organic fertilizer. This corroborates the findings of Hara (1998) who mentioned that the volume of pellets ranged from 50 – 80 % of the original volume of compost prior to pelleting.

Survival Rate of Microbes Present in the Pellets:

Observations showed that there were bacteria and fungi that had survived the harsh conditions during pelleting. These microbes grew in the Petri dishes because of the provision of NA and the PDA as their food. Subjecting these samples to total bacterial and fungal enumeration, Table 2 shows the colony count of bacteria after pelleting; 12 hours from incubation. Substrate C_1 had a mean of 50 colony-forming units per ml solution (cfu/ml). This implies that a gram of pelleted C_1 has 100 (50/0.5 g/ml) colony-forming units while substrate C_2 has a mean of 157 cfu/ml solution or 314 colony-forming units per gram of pellet. The difference of colony count between the two treatments is highly significant. In as much that C_1 received nitrogen enhancer, while C_2 did not received any, these fertilizers might have contributed in the reduction of microbes in C_1. However, there was no specific test on the factors that contributed in the reduction of bacterial colony except the pelleting process and the enhancer applied.

Table 2. Bacterial colony count in the fortified bio-organic fertilizer pellets 12 hours after incubation, (cfu)/ml

TRIALS	TEST MATERIALS		GRAND MEAN
	C_1	C_2	
1	30	200	
2	50	130	
3	70	140	
Mean	50[a]	157[b]	103.5

Means in a row with different letters are significant at 5% level of significance using t-test

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Table 3 shows the colony of molds from pelleted samples, 36 hours from incubation. The colony count of molds significantly differs between the two test materials. Substrate C_1 had a mean colony count of 70 cfu/ml; which implies that a gram of pelleted C_1 has 140 colony-forming units while substrate C_2 has a mean of 220 cfu/ml or 440 colony forming unit per gram of pellet. In as much that C_1 received nitrogen enhancer while C_2 did not received any, the effect of this might have resulted in the decrease of fungal count in C_1. Again, there was no specific test on the factors that contributed in the reduction of fungal colony except the pelleting process.

Table 3. Fungal colony count in the fortified bio-organic fertilizer pellets at 36 hours after incubation, cfu/ml

TRIALS	TEST MATERIALS		GRAND MEAN
	C_1	C_2	
1	50	190	
2	60	170	
3	100	300	
Mean	70^a	220^b	180

Means in a row with different letters are significant at 5% level of significance using t-test

Figure 2 shows the trend of bacterial and fungal colony count on the samples before and after pelleting. In the foregoing figures, pelleting substrates C1 and C2 gave a fungal survival rate of 33% and 87.22%, respectively while the survival rate In terms of bacteria, pelleting substrates C1 and C2 had a survival rate of 17.5% and 44%, respectively.

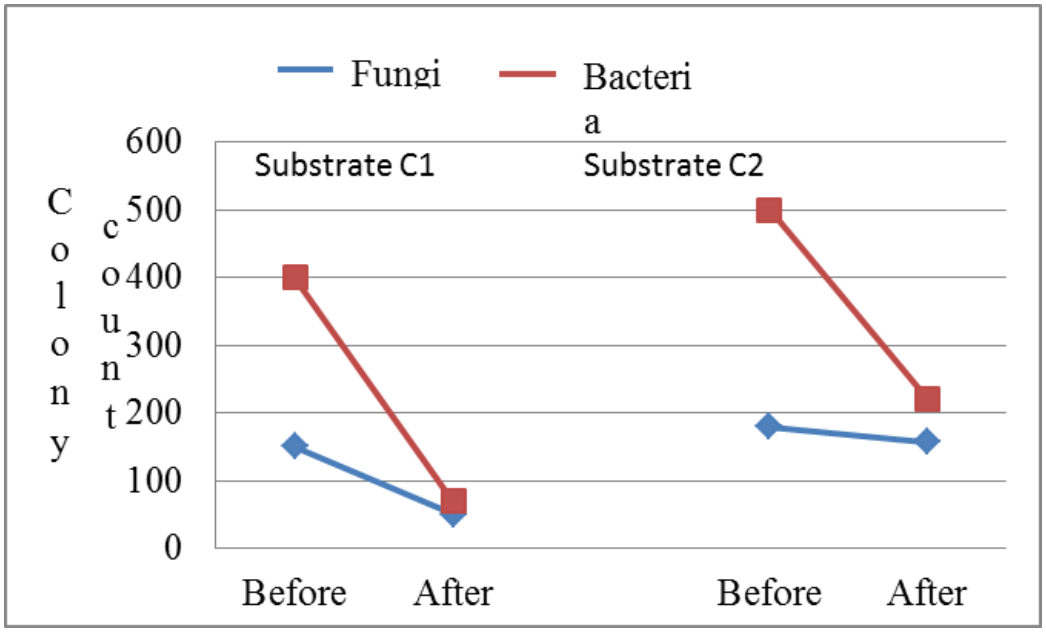

Figure 2. Bacterial and fungal colony counts of the samples before and after pelleting

It can be gleaned from the figures that pelleting greatly contributed to the reduction of both fungal and bacterial colony counts of the samples. This might have been attributed to the effects of several factors during the pelleting operation. Moreover, C1 had lower colony counts on bacterial and fungal than C2 hence it can be stated that the greater factor of microbial colony reduction might have been due to the effect of nitrogen enhancer applied to C1. While the pelleting process greatly affected the survival rate of the microorganisms, the study implies that the population of beneficial microbes could be further enhanced by manipulating some parts of the pelleting machine which was used in this study.

VII. CONCLUSION

The fortified compost pellets had a density of 889.82 kg/m3 which resulted to a 35% reduction in volume. Pelleting substrates C1 and C2 from their original form gave a fungal survival rate of 33% and 87.22%, respectively. As to bacterial colony count, pelleting substrates C_1 and C_2 had survival rates of 17.5% and 44%, respectively.

VIII. RECOMMENDATIONS

Pelleting the compost and organic fertilizer is an emerging fertilizer management strategy for crop production. However, the beneficial microorganisms present therein sometimes suffer or killed due to forces of pelleting. To prevent this situation, pelleting machine needs thorough awareness and understanding on the characteristics of the input materials and its prospective users. To further enhance the quality of the pellets, the following are recommended:

1. Reduce the temperature generated during pelleting by trying the following; (a) using a thinner plate; (b) using a bigger die size; (c) using Mild Steel (MS) plate;

2. Test other nutrient enhancers in the pellets

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