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Effect of Compost Made from Filter Cake and Distillery Slop on Sugarcane Growth

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Abstract

Compost is recycled of bio- degradable organic waste to be used bio fertilizer to promote plant nutrients uptake and influence soil physical and biochemical properties. This study aims to study decomposition of organic residues from sugar mill and alcohol factories, properties of compost product and its effect on plant growth. Germination test has shown that the compost made from filter cake and distillery slop was matured within 45 days and is within normal range of compost maturity duration. Organic matter and NPK content of the compost increased with time during composting and highest value was observed in compost samples taken on day 45. Even though there was no notable difference in maturity period, substrates inoculated with KKU microbes produced better results in all when compared to substrates inoculated by commercial compost microbes. Amending compost inoculated with KKU microbes with chemical fertilizer significantly increased shoot biomass and had a positive effect on growth and development of sugarcane. Though compost prepared from distillery slop and filter cake is a good source of plant nutrients, our result demonstrate that better results would be obtained if it amended with NPK fertilizers.

Keywords: compost, sugarcane, filter cake, distillery slop

1. Introduction

Filter cake and distillery slop are residues from sugar mill and alcohol factory respectively. Filter cake is produced by drum filters in sugar processing during juice clarification. Filter cake is a waste containing 1.8% total N, organic matter 48%, C/N ratio 14, total-P 0.96%, total-K 0.39%, total-Ca 7.1%, total-Mg 0.40%, pH 7.7, EC 0.80 dS/m and ash 52% (1). Distillery slop is a waste which produces highly organic pollutants and consisting of organic matter 3.7%, available P 0.02 %, available K 0.49%, ash 1.66% (2). The disposal of large quantities of distillery slop resulting from the manufacturer of alcohol from cane molasses is a problem.

Filter cake and distillery slope have been used as a source of nutrients in many parts of the world, especially in sugarcane farm. The use of these wastes as bio fertilizer and its positive impact on plant growth and soil biochemical and physical condition has been reported by many researchers. Elsayed[3] reported increased in germination percentage of sugarcane and nitrogen content of soil following applications of filter mud or mixture of filter mud and soil into soils. Jayasinghe[4] stated as the utilization of sewage sludge sugarcane trash based compost and synthetic aggregates is an inexpensive alternative to the use of peat in horticultural field. Silva[5] studied the effect

of different tannery sludge compost amendment rates on growth, biomass accumulation and yield responses of *Capsicum* plants and found that tannery sludge compost application had significantly increased the number of leaves, fruits stem length and chlorophyll content of sugarcane. The aim of this study was to (1) produce compost by using filter cake and distillery slop as the materials for composting process and (2) examine the effect of compost to seed of rice and corn and the growth of sugarcane.

2. Material and Methods

2.1 Starter culture preparation and composting

Microbial inoculums (KKU inoculums) were prepared as follow; 10^8 cell/ml of bacterial (isolate BFC8 and BDS31) and 10^8 spore/ml of actinomycetes isolate ACSI were inoculated in Nutrient Broth (NB) whereas 10^8 spore/ml of fungus (isolate FFC2) was inoculated in Potato Dextrose Broth (PDB). Each microbe was grown in 250 ml flask and incubated at 45 degree Celsius for 2 days (bacteria) or 7 days (actinomycetes and fungi).

A starter culture was prepared by spraying 1000 ml of microbial inoculum on 100 kg of filter cake. Four liters of distillery slop was sprayed on the inoculated filter cake heap every week. The substrates and inoculum mixture was thoroughly mixed by spinning every 10 days, and incubated outdoor for 30 days.

Filter cake and distillery slop from Khon Kaen alcohol factory were used for making compost. The first compost pile was made by treating mixture of substrates with microbial inoculums obtained from commercial compost microbes (CCI) and used as a control. Each of the remaining compost piles were inoculated by specific starter culture made from KKU microbial inoculums. Starter culture and filter cakes were mixed in a ratio of 1:10. Each treatment was sprayed with distillery slop spin every 7 days, and incubated for 45 days. Samples were collected from each treatment every 15 days. Compost field was laid in randomized complete block design and in five replications.

2.2 Study on change of temperature, pH, Electrical Conductivity (EC), Organic Matter (OM) and N P K of compost

The temperature was measured by inserting thermometer into 1ft of compost at the center of the heap. The compost pH and EC were measured by dipping pH and electrical conductivity meters into samples prepared by shaking 100 gram of compost sample in 100 ml of distilled Organic matter (OM) and total N content of the compost were measured according the Kjeldahl method. Total amount of P and K was measured by Spectrophotometric molybdovanadophosphate method and Flame photometric method, respectively. Compost samples were taken on first day, 15^{th}, 30^{th}, and 45^{th} days of composting and used for this study.

2.3 Measurement of seed germination by evaluating germination index (GI)

Mature compost age 45 days was used for seed germination testing of Rice and Sweet corn. Compost extract was prepared by diluting compost sample with distilled water in the ratio of 1:10, shaking for 3 hours at room temperature, and then extracting by filtration. Ten seeds of each plant were placed on tissue paper and incubated in glass plate with 5 ml of compost extract for 7 days in dark at room temperature. Distilled water was used as a control treatment. The seed germination was evaluated by measuring root length and counting the number of germinated seed. The germination index(%) was calculated by using the formula follow(6):

$$GI\ (\%) = \frac{\%\ \text{of germination in compost solution x root length in compost solution}}{\%\ \text{of germination in distilled water x root length in distilled water}} \times 100$$

2.4 Study on the effect of different treatments on growth of sugarcane.

This experiment was conducted in the greenhouse by growing sugarcane stem 10 cm long inside 12 inches diameter experimental pot for 120 days. The 6 treatments used for this experiment are indicated in table 1 below.

Table 1. Treatments for studying on the effect of compost to the growth of sugarcane in the pot experiment.

Treatments	Amount			
	Soil (kg)	KKU (kg)	CCI (kg)	Chem (kg)
Control	10	-	-	-
KKU	10	0.32	-	-
CCI	10	-	0.32	-
Chem + KKU	10	0.24	-	0.08
Chem + CCI	10	-	0.24	0.08
Chem	10	-	-	0.32

KKU = KKU microbial inoculums compost

CCI = commercial compost inoculums

Chem = chemical fertilizer

Treatment control = sugarcane grown on soil only

Treatment KKU = sugarcane was grown on a mixture of compost containing KKU microbial inoculums and soil

Treatment CCI = sugarcane was grown on a mixture of compost containing commercial microbial inoculums and soil

Treatment Chem + KKU = sugarcane was grown on a mixture of compost containing KKU microbial inoculums, soil and chemical fertilizer

Treatment Chem + CCI = sugarcane was grown on a mixture of comercial compost (CCI microbial inoculums), soil and chemical fertilizer

Treatment Chem = sugarcane was grown soil treated by chemical fertilizer. NPK inorganic fertilizer with 15-15-15 formula was used in this study

2.4.1 Analysis of the growth of sugarcane

Measurement of shoot weight

Shoot of sugarcanes was harvested on the 120 days to measure the fresh and dry weight. Dry weight was measured by drying the harvested shoots in 75 ^{o}C for 2 days.

Measurement of the amount N P K in shoot of sugarcane

The total N content of the shoot was measured according to micro-Kjeldahl and Indrophenol Blue methods. Colorimetric analysis was done by Flow Injection Analyzer at A_{590}.

Phosphorous content of the shoot was measured by Wet Oxidation method and Yellow molybdovanadophosphoric acid method. An analysis of colorimetric was performed by Spectrophotometer at A_{420}.

Total K in shoot of sugarcanes was assay by Wet Oxidation method with Flame photometer.

Statistical analysis

Analysis of variance was performed for each character according to a randomized complete block design. The least significant difference (LSD) was used to compare means using statistix 8 . The relationships among traits were calculated by the Pearson's correlation analysis using accession means. (7)

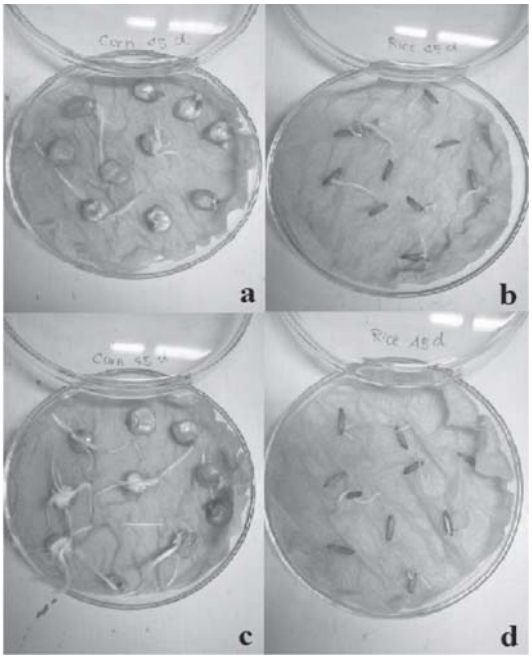

Figure 1. Sweet corn and rice seed germination when tested with KKU compost 45 days (a and b), tested with CCI compost 45 days (c and d).

3. Results and Discussion

3.1 Change of pH, EC (Electrical conductivity) and temperature during composting

Changes in pH and EC of compost during composting phases were given in table 2 and 3. The compost pH varied from 7.14-8.70, while EC was ranging from 1.82-2.89. These values are in range of Thai agricultural standard of compost (pH 5.5-8.5 and EC d" 3.5 dS / m)(8). The temperature in the compost pile progressively increased from day 0 to day 30 and thereafter decreased until 45 days. Rise in temperature of the compost shows activity of the decomposing microorganisms and healthy decomposition of organic matter of the compost pile. (table 2 and table 3)

Table 2. Change of pH, EC and temperature in the compost samples during CCI composting

Test	Day of sampling			
	0	15	30	45
pH	7.28	8.28	7.48	7.23
EC(mS/cm)	1.82	2.79	2.82	2.89
Temperature(°c)	42	55	58	47

The values showed in this table were the mean of two replicates

Table 3. Change of pH, EC and temperature in the compost samples during KKU composting

Test	Day of sampling			
	0	15	30	45
pH	7.14	8.21	8.70	8.63
EC(mS/cm)	2.28	2.77	2.81	2.35
Temperature(°c)	40	55	61	52

The values showed in this table were the mean of two replicates

3.2 Change of amount total N P K and OM (organic matter) in compost sample 45th days

The N, P and K are macro- nutrients that plants needs in relatively higher quantity for normal growth and development. Total N P K and OM contents of the compost sample were highest in sample taken on 30 and 45 days of composting (table 4 and table 5). Days of sampling compost which referred to age of compost had effected to the amount of total nitrogen(%), total phosphorus(%), total potassium(%) and organic matter(%). The statistically analysis of data showed significantly difference at 99% confidence level.

3.3 Germination Index (GI) of mature compost

The GI values of rice and sweet corn seeds incubated in extracts obtained from organic substrates treated with KKU and CCI starter inoculums had greater than 80% (Table 6), showing that the substrate in this compost was completely decomposed. The GI values of

Table 4. Change of total N P K and OM in compost samples during CCI composting

Age of compost (day)	Total N	Total P	Total K	OM
0	1.20 b	1.54 c	0.72 b	14.98 c
15	1.23 b	1.32 d	0.55 c	10.26 d
30	1.89 a	1.72 b	0.70 b	16.21 b
45	1.90 a	1.86 a	0.98 a	17.88 a
Mean	1.55	1.61	0.74	14.83
F-test	**	**	**	**
CV (%)	2.82	0.74	1.57	0.12

** = significant at $P < 0.01$ probability levels.

Mean in the same column with the same letters are not significantly difference by LSD (at $P > 0.05$). (7)

Table 5. Change of total N P K and OM in compost samples during KKU composting

Age of compost (day)	Total N	Total P	Total K	OM
0	1.32 c	1.50 c	0.68 b	14.82 c
15	1.24 d	1.31 d	0.45 c	10.89 d
30	1.63 b	1.64 b	0.68 b	15.83 b
45	1.73 a	1.74 a	1.33 a	17.23 a
Mean	1.48	1.55	0.79	14.69
F-test	**	**	**	**
CV (%)	1.31	1.03	2.21	0.13

** = significant at $P < 0.01$ probability levels.

Mean in the same column with the same letters are not significantly difference by LSD

rice and sweet corn seeds test with KKU and CCI composts showed significantly difference at statistical confidence level of 99%. Seed germination used as indicator of phytotoxicity. Phytotoxicity is salt related which found in immature compost and inhibit the growth of plants(9).

Results on effect of different growth media on growth of sugarcane as measured by fresh and dry weight is shown in table 7. A mixture of KKU compost and chemical fertilizer produced the highest fresh and dry weight biomass. The P K content of sugarcane shoot was not significantly affected by treatments, except for N content showed significantly difference in plants grown on media containing CCI inoculums. In line with Ingkapradit[10] showed 7-15 %productivity gain when rice is grown on a mixtures of filter cake and chemical fertilizer

Table 6. Germination index of sweet corn and rice seed at 7 days of incubation

Type of compost extract	GI(%)*of Sweet Corn	GI(%)*of Rice
KKU[1]	177.18 b	177.39 a
CCI[2]	183.66 a	93.910 b
T- test	**	**
SE	1.44	18.60

[1] Compost contained KKU microbial inoculums

[2] Compost contained Commercial microbial inoculums (CCI)

*Mean of three replicates

**=significant at $P<0.01$ probability levels. (7)

Table 7. Total of N P K (%w/w), Fresh and dry shoot weight of sugarcane 120 days

Treatments	Macro-nutrients in plant shoot (%)			Plant Growth	
	N	P	K	SFW (g)	SDW (g)
C	0.539c	0.125	4.969	36.03	12.94
KKU	0.832b	0.158	4.714	37.91	13.77
CCI	1.245a	0.149	6.036	34.26	12.39
Chem+CCI	0.789bc	0.149	4.888	34.63	12.78
Chem+KKU	0.709bc	0.116	4.980	44.10	15.21
Chem	0.663bc	0.129	4.585	43.60	15.14
Mean	0.796	0.138	5.029	38.42	13.71
F-test	**	ns	ns	ns	ns
CV (%)	33.84	27.85	12.63	19.52	11.92

4. Conclusion

Compost sample was collected for analysis from the compost heap every 15 days during different composting phases over 45days. pH, EC and temperature of the compost have shown significant change with age of the compost. The pH and EC of KKU and CCI compost ranged from 7.14-8.70 and 1.82-2.89, respectively. The temperature in the pile of compost increased from 0 to 60^{o}C on day 30 and thereafter gradually dropped to room temperature within 45 showing that the substrate used was undergoing normal decomposition process and maturity was attained within 45 days. The amount of N P K in compost samples falls within normal range of those compost considered suitable for crop growth and development, though the organic matter content was below the normal value of compost. This is because the organic matter in filter cake was considerably low. The higher germination index indicates completion of the decomposition process and maturity of the compost. When compost contained KKU microbial inoculum was harnessed with inorganic fertilizer containing NPK (15-15-15), it significantly

improved the growth of sugarcane as shown by highest gain in sugarcane shoot. Our finding implies that the growing sugarcane on compost made from filter cake and distillery slope inoculated with KKU microbes and amended with inorganic fertilizer in proper ratio would promote sugarcane growth.

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6. References

(1) Meunchang S, Panichsakpatana S, Weaver RW. Co-composting of filter cake and bagasse; by-products from a sugar mill. Bioresource Technol. 2005; Mar; 96;(4):437-442.

(2) Halm AT, Dennis EA. Compostion and possible use of filter-mud and slop water as soil improvement materials. Ghana Jnl Agric. Sci. 1976;(9):231-233.

(3) Elsayed MT, Babiker MH, Abdelmalik ME, Mukhtar ON, Montange D. Impact of filter mud applications on the germination of sugarcane and small-seeded plants and on soil and sugarcane nitrogen contents. Bioresource Technol. 2007; Oct 22;(99):4164-4168.

(4) Jayasinghe GY, Yoshihiro TLD. Liyana Arachchi, Mika Arakaki. Sewage sludge sugarcane trash based compost and synthetic aggregates as peat substitutes in containerized media for crop production. J. of Hazardous Materials. 2009; Sep 25; (174):700-706.

(5) Silva JDC, Leal TTB, Araújo ASF, Araújo RM, Gomes RLF, Melo WJ, Singh. RP. Effect of different tannery sludge compost amendment rates on growth, biomall accumulation and yield responses of *Capsicum* plants. Waste Management. 2010; Mar 31;(30):1976-1980.

(6) Zucconi F, Forte M, Monac A, Beritodi. M. Biological evaluation of compost maturity. Biocycle. 1981;(22): 27–29

(7) Gomez KA, Gomez AA. Statistical procedures for agricultural research. John Wiley & Sons, New York. 1984.

(8) National Bureau of Agricultural Commodity and Food Standards Ministry of Agriculture and Cooperatives. Compost. Thai agricultural standard TAS 9503 – 2005. Published in the Royal Gazette 2005;(122) Section 114D, dated 8 December B.E.

(9) Iannotti DA, Grebus ME, Toth BL, Madden LV, Hoitink HAJ. Oxygen respirometry toassess stability and maturity of composted municipal solid waste. J. Envirom. Qual, 1994;(23):1177-1183.

(10) Ingkapradit W, Pipatpiriyanont J, U-bol W. Paddy soil fertility improvement for rice production through the utilization of chemical fertilizer and filter cake. Thai Rice Research Journal, 2008; (2) No. 1, January - April