IJAIR

International Journal of Agriculture Innovations and Research
Volume 2, Issue 1, ISSN (Online) 2319-1473
Manuscript Processing Details (dd/mm/yyyy) :
Received : 07/08/2013 | Accepted on : 23/08/2013 | Published : 30/08/2013

Physico-Chemical Analysis of Soil before and After Mixing with Vermicompost of Industrial Effluents with Different Animal Dung

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***Abstract* – Sugar mill and distillery effluents are adversely affect the environment and its components. These effluents are having higher amount of harmful chemicals, chloride, sulphate, nitrate etc. Vermicomposting with earthworm *Eisenia fetida* is a suitable way for conversion of wastes in to rich organic bio-fertilizers. The physico-chemical properties of soil were observed before and after mixing of vermicompost of different combinations of effluents of sugar mill and distillery with animal dung. There was significant different in total Kjeldhal nitrogen (TKN), total available phosphorous (TAP), total potassium (TK), total calcium (TCa) level and significant decreased in C/N ratio, total organic carbon (TOC) and electrical conductivity (EC) of vermicompost with soil with respect to soil alone. The aim of present study was to determine the chemical compositions of soil before and after with vermicompost.**

***Keywords* – Vermicompost, Animal Dung, Sugar Mills and Distillery Effluents, *Eisenia Fetida,* Physico-Chemical Analysis, Soil.**

I. Introduction

Generation of millions of tons of sugar mill effluents, distillery spent wash and animal wastes are produced annually and have cause odor and pollution problems [1-4]. India being one of the largest producers of sugars in the world and the sugar mills are potentially producing about 182 lakh tonnes of sugar per year [5]. The total waste water produced per liter of alcohol production is around 40 to 50 liters [6]. About 40.72 million/ m3 spent wash is generated annually from distilleries in India, considerable amount of plant nutrients are available in distillery effluent like: N=1,660 to 4,200 mg/L, P=225 to 3,038 mg/L, K=9,600 mg/L, Cl=7,238 to 42,096 mg/L, Ca=2,050 to 7,000 mg/L, Mg=1,715 to 2,100 mg/L, SO_4=240 to 425 mg/L. Industrial wastes caused environmental hazards and various ill effects on the human health. Diverse sugar and distillery effluents directly disposed in soil and water cause major pollution problems. The sugar and distillery industry play an important role in the economic development of India but the effluents released produce a high degree of organic pollution in both aquatic and terrestrial ecosystem [7]. The byproducts of sugar industries are alcohol, molasses, and the mother liquor which is brown in colour with high temperature, low pH and high ash content [8]. Animal wastes are also a serious problem if not proper managed.

The world global growth and rapid industrial development have led to the recognition and increasing understanding of interrelationship between pollution, public health and environment. The microbial decomposition of the wastes produced various harmful gases which causes odour problems [2, 9]. The solid wastes of textile mill, sugar mill, dairy plant sludge and municipal solid wastes are harmful to human being and their cattle [10]. Effluent from distilleries contains large amounts of dissolved matter. These organic matters are readily decomposed by microbial decomposition consequently its discharge to river stream which affect the aquatic life stream. To use of appropriate technique for the management of harmful industrial wastes produced from cane sugar and distillery industries and will be help to change harmful effluents in to valuable and potent vermicompost as a product [11, 12].

Vermicomposting is the option for management of industrial wastes by epigeic earthworm which can convert biological wastes into nutrient rich organic manure by the help of epigeic earthworm *Eisenia fetida* [13, 14]. *Eisenia fetida* play an important role for management of these wastes [1]. Atharasopoulous [15] also used the vermibiotechnology for the management of aerobically established effluents of derived vine fruit industry. Vermicomposting is an eco-biotechnological process that transforms energy rich and complex organic substances into stabilized humus-like product–vermicompost.

The potent vermicompost used in sustainable agriculture because continuous use of chemical fertilizer has leaded to decline the soil fertility and productivity of agricultural crops and also causing deficiency and imbalance of micronutrients [16, 17] The aim of present study was to determine the chemical compositions of soil before and after treatment with vermicompost, after management of sugar mill and distillery effluents. The significant changed in chemical composition of soil due to addition of vermicompost, which is suitable for different crops.

II. Materials and Methods

A. Collection of industrial wastes and earthworm

Cane sugar and distillery effluents were collected from Saraiyan (Saradar Nagar) Sugar and Distillery mill, Saradar Nagar, Gorakhpur, UP. The different animal dung was collected from different farm houses of the Gorakhpur district. The cultured earthworm *Eisenia fetida* was used for vermicomposting.

B. Experimental setup for vermicomposting and mixed with soil

International Journal of Agriculture Innovations and Research
Volume 2, Issue 1, ISSN (Online) 2319-1473

Vermicomposting was conducted in the cemented earth surface. The different combinations of animal dung with sugar mill effluents/distillery effluents in different ratio. The size of each vermibed was kept 3m x 1m x 9cm. Prepared vermibeds were moist daily and inoculate 2 kg of cultured *Eisenia fetida* in each bed. The beds were covered with jute pockets and moisten the bed daily up to 40–50 days for maintaining the moisture content [14]. After one week interval, mixture of bed was manually turned up to 3 weeks. The prepared vermicompost was applied in the agricultural field @ 2 kg/m^2. The physico-chemical parameters were observed before and after soil, mixed with vermicompost of different combination of sugar mill sludge, distillery effluents and animal dung.

C. Chemical Analysis

The pH and electrical conductivity were determined using a double distilled water suspension of each wastes in the ratio 1:10 (w/v) that has been agitated mechanically for 30 minutes and filtered through Whatsman No. 1 filter paper, and temperature was mentioned by digital thermometer. Total organic carbon was measured by the method of Nelson and Sommer [18]. Total Kjeldahl nitrogen was determined after digesting the sample with Conc. H_2SO_4 and Conc. $HClO_4$. (9:9 v/v), according to the method of Bremner and Malvaney [19]. Total phosphorus was analyzed using the calorimeter method with molybdenum in sulfuric acid [2]. Total potassium was determined after digesting the sample in diacidic mixture (HNO_3: HClO4 = 4:1, v/v), by flame photometer (Elica, CL 22 D, Hyderabad, India).

D. Statistical Analysis

All the studies were replicated at least 6 times mean ± SD. One way analysis of variance applied in between cane sugar and distillery effluents with vermicompost of different combinations of animal dung, soil and soil with vermicompost [20].

III. Result

The different physico-chemical parameters of soil before and after mixing with different vermicompost of combinations of sugar mill sludge and distillery influents with animals dungs (cow, buffalo, goat and pig) was observed. There was significant increase in the level of TOC, TKN, TK, TP and TCa whereas, the significant decrease was observed in pH, EC and C/N ratio in vermicompost of different combination with animal dung (Table. 1-2).

In our previous works Rai and Singh [4] reported that the physico-chemical texture of vermicomposts of different combinations of sugar mills, distillery effluents with animal dung. There was a significant increase in total Kjeldahl nitrogen (TKN) in cow dung, total available phosphorous (TAP) in distillery effluents, total potassium (TK) in distillery effluents, total calcium (TCa) in sugar mill effluents+buffalo dung level and significant decreased in C/N ratio in distillery effluents +cow dung, total organic carbon (TOC) in sugar mill effluents, electrical conductivity (EC) in cow dung of final vermicompost with respect to initial feed mixture were observed.

The present study the significant physico-chemical parameters of soil before and after mixing with vermicompost of soil of sugar mill effluents, distillery effluents and different animal dung (Table-1 and 2). The vermicompost were responsible for changing nature of soil due to vermic-activity. The pH was significantly changes slightly basic to neutral or slightly acidic in soil after mixed with the vermicompost of different combinations of industrial effluents. The maximum low pH (6.6±0.12) was observed in soil with vermicompost of sugar mill effluents +buffalo dung (in 1:1 ratio). The significant increased EC was observed in soil with adding of different industrial vermicompost and high EC was recorded in the soil with vermicompost of sugar mill effluents (2.9±0.08 dS/m). The vermicompost of sugar mill effluents+cow dung showed that the TKN value was significant high (11.0±0.05 g/kg) in soil after mixing that vermicompost. The C/N ratio was decreased in the in soil if added vermicompost of sugar mill effluents +distillery effluents (1:2 ratio) in soil. TK and TP were exposed the maximum value (8.2±0.24 and 6.2±0.16 g/kg respectively) in distillery effluents whereas, TCa (2.1±0.4 g/kg) in the combination of control sugar mill effluents+buffalo dung (Table 1and 2).

IV. Discussion

The data obtained from result showed the significant changes in the soil after adding the vermicompost due to vermic-activity in vermicomposting. The *E. fetida* was responsible for changing different physico-chemical parameters in different combinations. The significant decrease pH was observed in soil after adding of vermicompost because nitrogen retention as this element is lost as volatile ammonia at higher pH value [21].

In all the vermicompost decreased TOC compare to initial feed mixture due to released CO^2 during respiration [11, 22]. The significant decreased C/N ratio was observed in vermicompost of industrial effluents with animal dung than control due to respiration as well as production of mucus and nitrogenous excreta so result decrease in final vermicompost [11, 23, 24]. The earthworm *E. fetida* in cow dung slurry increased the nitrate-nitrogen content [25] so the conc. of nitrogen increased in soil. Tripathi and Bhardwaj [23] stated that reduced the organic carbon might be responsible for nitrogen addition in the form of nitrogenous excretory substances, growth stimulatory hormone and enzyme from the gut of earthworm. Neilson [26-27] and Tomati [28] have also reported that vermicompost contained growth promoting hormone auxins, cytokinins and flowering hormone gibberellins secreted by earthworms. Kaviraj and Sharma [29] reported that TK was increased 5% by *Lampito mauritii* and 10% by the *Eisenia fetida* during the earthworm activity in different biological wastes. The concentration of N,P,K increased in soil due to adding vermicompost of industrial effluents and animal dung due to mineralization of these elements by the help of microbial and enzymatic activity in gut of earthworm [30]. Senthilkumar and Sekar [31] reported that the application of vermicompost increased the value of plant height, leaf area, dry matter content and yield after using of vermicompost in soil, may be due to the higher rate of multiplication of soil microbes leading to improvement in physical properties of soil.

V. Conclusion

This study concludes that the different types of vermicompost prepared from industries effluents with animal dung, utilized for the improving the soil fertility which important for the crops. The vermicompost of different industrial wastes can be utilized as an organic fertilizer instead of being disposed in landfills. The vermicomposting is an easy and effective way to recycling of industrial wastes in to nutritious compost by earthworm *Eisenia fetida* activity. During these process important plant nutrient such as nitrogen, phosphorus potassium, calcium etc. present in feed materials converted in to more absorbable form, for plant. It increases the porosity, aeration, drainage, water holding capacity, which reduced the irrigation water requirement for crops. It improves nutrients availability and could act as complex fertilizer granules and evolves great reduction in the population of harmful pathogenic microorganism and eco-friendly.

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Author's Profile

Mr. Rahul Rai
Research Scholar, Department of Zoology. Deen Dayal Upadhyay Gorakhpur University, Gorakhpur, U.P. India, born on 15 July 1985, M.Sc. in Zoology (2007), specialization Entomology. Teaching experience two years. Attended 4 National Conference/ Symposium/ Workshop and published three papers in International Journal. Actively engaged in research field of vermibiotechnology.

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Lecturer, Department of Zoology, D.D.U. Gorakhpur University, Gorakhpur, (U.P.), INDIA, born on 26th January, 1970. M.Sc. Zoology with specialization in Entomology in 1991, Ph.D. in Zoology in 1997 title of the thesis "Studies on molluscicidal activity of Azadirachta indica A. Juss (Neem) against harmful gastropods". More than 28 research papers published in journals of international repute and written two books (Enzyme inhibition by different bait formulation against the snail Lymnaea acuminata. Environmental pollution and toxicology Eds. (B.D. Joshi, P.C. Joshi and Namita Joshi) A. P. H. Publishing Corporation, India, 2008 and Vermicomposting: A Boon for Soil, Plant and Environment, Lambert publishing Academy, Germany, 2011). Worked as Senior Research Fellow in project of ICAR, New Delhi (1995-1996) and DBT, New Delhi (1996-1999). Presented 5 research papers in National seminars/ conferences/ symposia. Teaching experiences 18 years in UG and PG classes. Three students have been awarded Ph. D. degree and four students are currently registered for Ph. D. degree under my supervision. One major research project (UGC New Delhi) completed. Actively engaged in research activities for the last twenty years in field of Toxicology, Biochemistry and Phermacology. Worked for Ph.D. degree on control of harmful gastropods by using the plant product biopesticides. The harmful gastropods; Lymnaea acuminata and Indoplanorbis exustus are the intermediate hosts of Fasciola hepatica and F. gigantica causes faciolisasis in cattle population. The use of natural molluscicides for control of gastropods are safe for the environment, less expensive, easily available and easily biodegradable. For last six years actively working on vermibiotechnology, waste management by using earthworm Eisenia foetida. Vermicomposts and vermiwash with biopesticides have a significant effect on the growth, productivity and pest infestation. Organized two formers awareness programme on preparation and use of vermicompost and vermiwash for their benefit. I have been Assistant Proctor, Assistant Dean Student welfare, Chairperson of Athletics Association, admission committee and at present, Programme Officer in National Service Scheme (NSS), Chair person of athletics Association and Assistant Proctor of Deen Dayal Upadhyaya, Gorakhpur University, Gorakhpur.

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Table 1: Different physico-chemical parameters of soil after mixing with vermicompost of sugar mill, distillery effluents and cow and buffalo dung through vermicomposting by Eisenia fetida

Wastes Combinations	**Ratio**	**pH**	**EC (dSm^{-1})**	**TOC (g/kg)**	**TKN (g/kg)**	**C/N ratio**	**TK (g/kg)**	**TP (g/kg)**	**TCa (g/kg)**
Soil	-	7.1±33	1.5±0.4	56±2.1	0.66±0.08	41±1.21	0.52±0.02	0.41±0.03	0.52±0.24
Soil + following vermicompost									
SME	-	7.0±0.10	2.9±0.08*	80.5±1.21*	1.3±0.12*	45.6±1.24	0.21±0.01*	2.1±0.08*	1.8±0.05*
DE	-	6.9±0.12*	1.8±0.08*	90.2±1.56*	2.3±0.05*	51.2±1.41*	8.2±0.24*	6.2±0.16*	1.7±0.05*
SME+DE	1:1	7.1±0.10	2.0±0.03*	65.2±1.31*	1.8±0.07*	46.6±1.12*	4.5±0.20*	5.5±0.09*	1.5±0.05*
CD	-	6.9±0.13*	2.1±0.06*	60.2±1.24*	15.4±0.10*	47.3±1.54*	3.9±0.15*	4.2±0.07*	1.2±0.03*
SME+CD	1:1	6.8±0.12*	2.3±0.08*	58.4±1.20*	8.5±0.03*	48.7±1.54*	1.8±0.09*	2.8±0.09*	1.6±0.5*
SME+CD	1:2	6.9±0.12*	2.3±0.06*	56.0±1.19*	11.0±0.05*	44.2±1.20*	2.2±0.10*	3.6±0.05*	1.1±0.5*
DE+CD	1:1	6.9±0.09*	2.1±0.05*	82.0±1.18*	8.7±0.11*	51.2±1.46*	5.3±0.07*	5.2±0.14*	1.0±0.4*
DE+CD	1:2	6.8±0.08*	2.0±0.12*	80.2±1.12*	11.3±0.05*	58.5±1.14*	5.2±0.11*	4.8±0.10*	1.3±0.5*
SME+DE+CD	1:1:1	6.9±0.12*	2.0±0.03*	69.1±1.10*	8.6±0.14*	56.3±1.19*	4.2±0.14*	4.9±0.17*	1.7±0.3*
SME+DE+CD	1:1:2	6.9±0.10*	2.1±0.16*	70.3±1.23*	10.4±0.10*	59.1±1.27*	3.8±0.07*	4.1±0.07*	1.5±0.4*
BD	-	6.8±0.15*	1.2±0.05*	78.5±1.16*	15.0±0.14*	55.2±1.42*	4.0±0.12*	3.8±0.05*	1.9±0.6*
SME+BD	1:1	6.6±0.12*	2.0±0.04*	70.3±1.13*	8.6±0.14*	54.2±1.13*	2.9±0.10*	3.1±0.05*	2.1±0.4*
SME+BD	1:2	6.8±0.13*	1.5±0.07*	74.3±1.29*	9.7±0.10*	57.7±1.17*	2.8±0.13*	3.3±0.09*	1.9±0.7*
DE+BD	1:1	6.9±0.15*	1.5±0.06*	83.2±1.13*	8.8±0.10*	53.2±1.29*	6.3±0.14*	4.9±0.08*	1.6±0.5*
DE+BD	1:2	6.8±0.07*	1.4±0.03*	81.4±1.16*	10.7±0.20*	54.3±1.38*	5.8±0.07*	4.7±0.05*	1.4±0.5*
SME+DE+BD	1:1:1	6.7±0.05*	1.6±0.06*	75.4±1.14*	8.4±1.10*	58.3±1.57*	4.1±0.14*	4.5±0.09*	1.7±0.7*
SME+DE+BD	1:1:2	6.9±0.07*	1.5±0.03*	76.3±1.16*	10.5±0.04*	55.2±1.47*	4.7±0.07*	4.1±0.07*	1.5±0.4*

DE= Distillery effluents, CD= Cow dung, BD= Buffalo dung

Each value is the mean ± SD of six replicate. One way analysis of variance (ANOVA) was applied for significance ($P<0.05$) between different physico-chemical parameter of sugar mill, distillery sludge and different animal dung with soil control.

Table 2: Different physico-chemical parameters of soil after mixing with vermicompost of sugar mill, distillery effluents and goat, pig dung through vermicomposting by Eisenia fetida

Wastes Combinations	**Ratio**	**pH**	**EC (dSm^{-1})**	**TOC (g/kg)**	**TKN (g/kg)**	**C/N ratio**	**TK (g/kg)**	**TP (g/kg)**	**TCa (g/kg)**
Soil	-	7.1±33	1.5±0.4	56±2.1	0.66±0.08	41±1.21	0.52±0.02	0.41±0.03	0.52±0.24
Soil + following vermicompost									
SME	-	7.0±0.10	2.9±0.08*	80.5±1.21*	1.3±0.12*	45.6±1.24	0.21±0.01*	2.1±0.08*	1.8±0.05*
DE	-	6.9±0.12*	1.8±0.08*	90.2±1.56*	2.3±0.05*	51.2±1.41*	8.2±0.24*	6.2±0.16*	1.7±0.05*
SME+DE	1:1	7.1±0.10	2.0±0.03*	65.2±1.31*	1.8±0.07*	46.6±1.12*	4.5±0.20*	5.5±0.09*	1.5±0.05*
GD	-	6.9±0.08*	1.3±0.07*	65.2±1.17*	5.6±0.09*	61.3±1.82*	3.9±0.12*	3.2±0.07*	2.0±0.08*
SME+GD	1:1	6.8±0.16*	1.8±0.04*	60.2±1.59*	3.8±0.10*	60.7±1.54*	2.2±0.07*	2.8±0.05*	2.1±0.11*
SME+GD	1:2	6.6±0.05*	1.6±0.09*	61.4±1.17*	4.6±0.14*	61.2±1.42*	2.6±0.10*	2.9±0.08*	2.2±0.14*
DE+GD	1:1	7.1±0.13	1.4±0.08	63.7±1.15*	3.9±0.14*	62.1±1.21*	5.8±0.07*	4.8±0.09*	1.7±0.24*
DE+GD	1:2	6.9±0.16*	1.4±0.08	62.3±1.16*	4.7±0.29*	61.9±1.24*	5.4±0.08*	4.2±0.07*	1.6±0.6*
SME+DE+GD	1:1:1	7.0±0.04*	1.8±0.07*	60.2±1.31*	3.3±0.14*	57.3±1.30*	3.7±0.12*	4.6±0.05*	1.7±0.3*
SME+DE+GD+	1:1:2	6.9±0.05*	1.4±0.06	66.4±1.19*	4.2±0.10*	63.2±1.29*	3.6±0.09*	3.9±0.08*	1.4±0.5*
PD	-	7.2±0.06*	1.1±0.06*	67.7±1.27*	5.2±0.11*	62.1±1.57*	3.8±0.14*	3.7±0.06*	1.3±0.52*
SME+PD	1:1	6.9±0.05*	1.8±0.07*	60.2±1.16*	3.8±0.11*	54.2±1.19*	2.3±0.10*	3.1±0.12*	1.8±0.20*
SME+PD	1:2	7.1±0.06	1.2±0.08*	62.7±1.37*	3.7±0.34*	61.7±1.17*	2.9±0.11*	2.8±0.06*	1.7±0.09*
DE+PD	1:1	7.2±0.07*	1.0±0.04*	61.9±1.64*	3.1±0.41*	56.2±1.24*	5.2±0.09*	4.9±0.12*	1.3±0.08*
DE+PD	1:2	7.3±0.05*	0.9±0.02*	63.2±1.16*	3.2±0.07*	55.9±1.54*	5.0±0.08*	4.1±0.12*	1.2±0.07*
SME+DE+PG	1:1:1	7.2±0.07*	1.3±0.04	61.8±1.35*	3.4±0.06*	58.3±1.20*	3.1±0.07*	4.2±0.04*	1.6±0.06*
SME+DE+PG	1:1:2	7.0±0.11*	1.1±0.03*	62.7±1.35*	4.6±0.16*	54.1±1.27*	3.3±0.09*	3.6±0.14*	1.5±0.07*

SME=sugar mill effluents, DE= Distillery effluents, GD= Goat dung, PD= Pig dung
Each value is the mean ± SD of six replicate. One way analysis of variance (ANOVA) was applied for significance ($P<0.05$) between different physico-chemical parameter of sugar mill, distillery sludge and different animal dung with soil control.