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Assessment of agro potential of sugar industrial sludge

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ABSTRACT

The study of physicochemical parameters of sludge from sugar industry in which the observed percent Sodium (14.45 me/L) and SAR value (3.78 me/L) were found to be well within the permissible limits indicating its suitability as a landfill for irrigation purposes. The ratio of Nitrogen to potassium is found to be 17.53:1, while the phosphorus content is at below detectable limit. Hence as a land fill material it can partially replace the commercially used nutrient formulations. The presence of macro-nutrients such as calcium (1070 mg. Kg^{-1}) and Magnesium (2156 mg. Kg^{-1}) is a valuable input for effective utilization of this sludge for irrigation purpose. In our present investigation the heavy metal concentrations are well below the permissible limits and hence cause no concern. The present studies have been carried out on germination and seedling growth of four vegetable crops to assess the agro potential of the sludge.

Key words: Sludge, Nutrient, Sodium Absorption Ratio (SAR), Irrigation and Heavy metal.

INTRODUCTION

One of the major industries that generate large quantities of recyclable organic materials is the sugar industry. India being the second largest producer of sugar in the world and is a seasonal industry[1] Uncontrolled urbanization and industrial expansion leads to serious environmental problems through generation of huge quantities of organic waste or sludge materials, characterized with high organic matter and plant nutrients. This provides an opportunity to use these sludge materials as nutrients source in wasteland reclamation.

The studies[2] made an attempt to utilize nutrient rich industrial and domestic organic wastes from sugar industry and municipal sludge along with farm yard manure as a control, for effective

reclamation of degraded land. Organic carbon content ranged from 20 – 46 %; nutrient contents were: N – 0.37 to 1.69 %, P – 0.17 to 1.64 %, and K – 0.10 to 0.73 %. Nitrogen and phosphorous content was substantially high in sugar industry waste. The investigative results [3] indicate positive effects on soil properties from the application of sugar by-products by enhancing the levels of labile K, Cu and Zn, along with substantial increases in organic carbon status. Studies [4] are carried out on the methodology to convert filter cake from sugar industry into bio-compost using two exotic, epigeic earthworms, Eisenia foetida, a Chinese species, and Eudrilus eugeniae, an African species. Results indicate, Eudrilus eugeniae can compost sugar factory waste filter cake into a useful organic fertilizer. A method [5] was described for the preparation of calcium hydroxide fertilizer utilizing sludge from sugar industry. The studies [6] revealed that pre lining sediment is rich in calcium, phosphorus, and protein and trace minerals (Fe, Zn, Mn, Cu) and contains no appreciable residues of heavy metal and pesticides. The optimum conditions obtained [7] for heavy metal extraction from sugar sludge incorporating the parameters like influence of the acid concentration employed, agitation time and liquid to solid ratio.

Keeping in view of the agricultural back ground in East Godavari region of Andhra Pradesh, India and sugar cane being one of the major crops and sugar industry being the most prospective industry of this region, it is proposed to characterize the sugar industrial sludge to assess its agro potential.

MATERIALS AND METHODS

Sampling site: Sugar industry with a production capacity of 250 tons/day located in East Godavari district of Andhra Pradesh, India generating 220 Kg/day sludge has been selected for analysis to assess its Agro potential.

The sludge sample is dried at 105^{o}C and it is powdered and used for analysis as per the standard procedures [8,9,10] for parameters such as pH, electrical conductivity, moisture, volatile solids, fixed solids, total organic carbon, calcium, magnesium, sodium, potassium; percent sodium, sodium absorption ratio (SAR), total nitrogen and total phosphorus and the data is presented in table – 1.

Table –1: Characterization of Sludge

S.No	Parameter	Observed Value	Standard Value
1.	pH	8.4	-
2.	Electrical Conductivity (µmhos/cm)	1078	-
3.	Moisture (%w/w)	54.38	-
4.	Volatile solids (%w/w)	17.30	-
5.	Fixed solids (Ash content) (%w/w)	82.70	-
6.	Total organic content (TOC) (%w/w)	27.79	-
7.	Sodium (mg/kg)	936	-

8.	Potassium (mg/kg)	372	-
9.	Calcium (mg/kg)	1070	-
10.	Magnesium (mg/kg)	2156	-
11.	Kjeldahl nitrogen (mg/kg)	6524	-
12.	Total phosphorus (mg/kg)	BDL	-
13.	Percent Sodium (me/L)	14.45	60 me/L
14.	Sodium Absorption Ratio (SAR) (me/L)	3.78	26 me/L

Heavy metal concentration:
The sludge has been analyzed for Heavy Metals as per the standards [CPCB, 2000] and the levels of heavy metals are well below the permissible limit and hence cause no concern. The details are presented in Table – 2

Table –2: Concentration of heavy metals in Sugar sludge:

Type of heavy metal	Concentration (mg/Lit)		
	Observed value	Ref.-7	CPCB Schedule-2 [rule 3(1) (b)]
Chromium (Cr.)	27	--	5000
Manganese (Mn)	610	--	--
Iron (Fe)	9900	--	--
Cobalt (Co)	BDL	--	5000
Nickel (Ni)	30	83.15	5000
Copper (Cu)	72	32.45	5000
Zinc (Zn)	57	94	20000
Cadmium (Cd)	5.2	3.5	50
Lead (Pb)	312	62.64	5000

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Investigative study on Seedling Growth of vegetable crops in sludge composite
Since the sludge has the manure potential with N**:** P**:** K = 17.53**:** BDL**:** 1, an investigative study has been taken up on the Seedling growth of vegetable crops such as Abelmaschus esclentus (Lady Finger or Okara), Cyanmopsis tetragonoloba (Clustered beans), Lycopersicon esclentum (Tomato) and Solanum melongea (Brinjal). The Pot level cultivation platforms employed for this study are (a) Black soil alone as Control and (b) Sludge Composite with Black soil (1:1) and the details are presented in Table – 3

Table – 3: Seedling growth of vegetable crops in Black soil (control) and sludge with black soil (1:1)

Lady finger	Cultivation Platform	Period of observation (Number of days after seeding)						
		2	4	6	8	10	15	20
		Plant Height (cm)						
A	Block Soil Alone	Germination Observed	1	4	6	10	11.2	14.00
B	Black Soil + Sludge	Germination Observed	Germination Observed	3	6.5	10	12	15.00

C-Beans	Cultivation Platform	Period of observation (Number of days after seeding)						
		2	4	6	8	10	15	20
		Plant Height (cm)						
A	Black Soil Alone	Germination Observed	1.60	5.50	5.80	6.00	7.00	9.00
B	Black Soil + Sludge	Germination Observed	1.00	5.00	6.00	7.20	11.00	12.00

Tomato	Cultivation Platform	Period of observation (Number of days after seeding)						
		2	4	6	8	10	15	20
		Plant Height (cm)						
A	Black Soil Alone	Germination Observed	0.60	4.00	4.00	4.00	4.50	7.00
B	Black soil + sludge	Germination Observed	Germination Observed	3.20	4.5	5.5	7.4	10.40

Brinjal	Cultivation Platform	Period of observation (Number of days after seeding)						
		2	4	6	8	10	15	20
		Plant Height (cm)						
A	Black Soil Alone	--	--	0.80	1.50	2.40	3.20	4.00
B	Black soil + sludge	--	--	0.40	1.60	2.70	4.50	7.00

Germination and Seedling growth of the vegetable crops in Soil alone & Sludge Composite with Soil on 20th day are presented in Figures 1(a) , 1(b); 2(a), 2(b); 3(a),3(b); and 4(a) and 4(b)

Germination and Seedling growth of the vegetable crops in Soil alone & Sludge Composite with Soil on 20th day

Fig- 1(a): LADY FINGER IN SOIL ALONE (20 d)

Fig- 1(b):LADY FINGER IN SLUDGE + SOIL (20 d)

Fig-2(a):**C-BEANS IN SOIL ALONE (20 d)**

Fig-2(b):C-BEANS IN SLUDGE + SOIL (20 d)

Fig-3(a): TOMATO IN SOIL ALONE (20 d)

Fig-3(b):TOMATO IN SLUGE + SOIL (20 d)

Fig-4(a): BRINJAL IN Soil (20 d)

Fig- 4(b): BRINJAL IN SLUDGE + SOIL (20 d)

RESULTS AND DISCUSSION

P^H and Electrical Conductivity

The pH of the Sludge is 8.4l and it is within the no problem range of 6.5 – 8.5 [12].Soils with Electrical Conductivity greater than 4000 µmhos/cm [13] which has saline in nature and generally not recommended for irrigation purposes. When compared to these soils, the sludge generated from Sugar Industry has an Electrical Conductivity 1078 µmhos/cm, which is with in the permissible limits and hence the Sludge can be considered for irrigation purposes.

Percent Sodium and Sodium Absorption Ratio (SAR)

Soils with percent sodium values grater than 60 are not suitable for irrigation purposes [14]. Soils with sodium Absorption Ratio (SAR) values greater than 13 are generally not recommended for irrigation [15].The values of percent sodium (14.45 me/L) and SAR (3.78 me /L) of the sludge are well within the permissible limit and can be considered for irrigation purposes.

Manure Potential

The manure potential of the sludge is assessed from N P K content and the NPK ratio is 17.53: BDL*: 1 (*Below Detectable Limit).These results revealed that the sludge has nutrient potential in terms of Nitrogen, and Potassium.

Germination and seedling growth of vegetable crops

1) All observations were made over a period of 20 days and germination was observed after 2 days of seedling except in case of Brinjal.
2) The observations on the 20th day revealed that In case of Lady Finger the plant height in black soil alone is 14cm while the plant height in sludge composite with black soil is 15cms. In case of C- Beans the plant height is 12cms in sludge composite with black soil which is higher than the plant height 9cm in Black soil alone. Tomato plant height in sludge composite with black soil is 10.4cms while the plant height in black soil alone is 7.0cms. In case of Brinjal the plant height is 7cm in sludge composite with black soil which is higher than the plant height 4cm in Black soil alone.

CONCLUSION

1. The lower values of percent sodium (14.45 me/L) and SAR (3.78 me/L) in respect of sludge indicate that the sludge can be used for irrigation purposes.
2. The heavy metal concentrations in the sludge are well with in the permissible limits.
3. The observations made after 20 days through pot level cultivation experiments revealed that the sludge composite with Black soil is more suitable for the cultivation of Abelmoschus esclentus (Lady Finger),Cyanmopsis tetragonoloba (C-Beans), Lycopersicon esclentum (Tomato) and Solanum melongea (Brinjal) crops.

Hence sludge form sugar industry with the combination of Black Soil can be considered for the cultivation of Abelmaschus esclentus (Lady Finger), Cyanmopsis tetragonoloba (Clustered beans), Lycopersicon esclentum (Tomato) and Solanum melongea (Brinjal).

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