Studies on Application of Spent Wash as a Nutrient for Agriculture Waste Composting

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Abstract. Due to high organic loading rates, several chemicals in distillery spent wash have high B.O.D. and C.O.D. values. The cost of treating and disposing of spent wash is expensive. Hence Composting is one of the most effective methods for achieving this. Sugarcane farms agricultural waste is used as a raw material. The goal of this study is to figure out how to compost agricultural waste utilizing aerobic and windrow composting techniques. Pits should be 3m long, 1.5m wide and 1m high for aerobic composting, and 3m long, 1.5m wide, and 1.2m high for windrow composting (Composting, W.H.O Book). Turning should be done on the 5th, 17th, and 30th days of the interval for aerobic composting. For windrow composting, it should be provided after 2-4 weeks. To decompose the agricultural waste cow dung and spent wash were utilized as a media. The study research indicates that it should be cost-effective. The quality of nitrogen, phosphorus, potassium and the mass of carbon to nitrogen ratio (C/N ratio) were analyzed. The parametric values, such as nitrogen 0.8 percent, phosphorous 0.4 percent, potassium 0.4 percent, and C/N ratio = 20 to 30, are all within acceptable ranges, and the results show that the compost is ideal for plant growth.

Index Terms: Spent wash, Nutrient , Cowdung, Agricultural waste

I. INTRODUCTION

Composting is the natural process of microorganisms rotting or decomposing organic materials under controlled conditions. After composting, raw organic resources such as crop leftovers, animal wastes, and eligible industrial wastes improve their potential for use as a fertilizing resource in the soil. Because the spent wash is acidic and contains several organic and inorganic salts, it has a high EC. The waste wash contains a lot of plant nutrients and organic material because it is made from plants. Excessive amounts of nitrogen, phosphate, and potassium are also available. As a result, it can be used as a soil supplement as well as a source of plant nutrients. The main purpose of this article is to increase the use of composting systems on farms, with the awareness that expanding their popularity is vital to enhance manure disposal while simultaneously protecting the environment.

Some information has been published on uses of spent wash, other information was found on how it effect on environment effect and soil fertility.

Susheel Kumar Sindhu *et al.*, (2007) The potential benefit and issues related with the use of spent wash in Rampur District were investigated, as well as the environmental consequences. While spent wash treatment at larger doses (> 250 m3 / ha) is found to be deleterious to crop growth and soil fertility, it is found to significantly boost germination, growth, and yield of dry land crops when used at lower doses (125 m3 /ha). Furthermore, under dry land circumstances, a combination of spent wash and organic amendments (farm yard manure, green leaf manure, and bio- compost) has been found to be effective.

Sarika Goel *et al.*, (2017) India is the world's largest producer and user of sugar. This distillery produces a large amount of spent wash, which is disposed of in water bodies and on land, causing a variety of environmental issues. To overcome this, the spent wash can be used in agriculture as a source of irrigation, fertilizers, and manure. If utilised after sufficient dilution, spent wash can improve crop productivity in agriculture. The purpose of this study was to see how irrigation affected different soil qualities.

Radha Jain & S. Srivastava , (2012) The nutrient composition of spent wash was investigated, as well as the effect of its application on sugarcane growth and biochemical characteristics. Essential nutrients (P, S, Fe, Mn, Zn, Cu) were found in higher amounts in wasted wash. Higher doses of wasted wash, on the other hand, significantly reduced these parameters, with the exception of peroxidase. The results showed that a low rate of wasted wash has a stimulatory effect on root and shoot growth, while a higher dose of spent wash has an inhibitory effect. As a result, smart application of spent wash will boost crop growth while also reducing pollution.

M. S. Soundariya et al., (2017) Spentwash is a highly concentrated liquid waste produced by distilleries. Due to its high nutrient content, many farmers use this wastewater as a

Shubham Shankar Magdum, Gopal M. Bhosale – "Studies on Application of Spent Wash as a Nutrient for Agriculture Waste Composting", Pg no: 69 – 75. 2022
doi.org/10.36647/978-93-92106-02-6.14

liquid fertiliser. However, the salts and nutrients in the effluent leak into ground water as a result of continual spentwash irrigation, posing an environmental problem. To monitor groundwater leaching, piezometers were put in farmers fields at a depth of 0.5 m in both spentwash applied and control fields, and leachates were collected on the 30, 60, 90, and 120th days following spentwash application. The results showed that the leachate's EC and salt content grew at first on the 30th day, then reduced on the 60th day. To avoid groundwater contamination with nitrate, salts, and other hazardous ions, spentwash must be applied carefully according on crop requirements and soil fertility state.

Shivarajkumar M. Kamble et al., (2017) The distillery spent wash has a high percentage of organic load. However, they are difficult and expensive to treat. Pollution prevention focuses on lowering the volume or toxicity of hazardous wastes through water recycling and reuse, whereas waste minimization focuses on reducing the volume or toxicity of hazardous wastes. Distillery spentwash is frequently applied on land for the sake of water pollution management and agricultural production. As a result, applying spentwash as irrigation water to the land in a controlled method aids in restoring and maintaining soil fertility, increasing soil microflora, and improving the physical and chemical properties of the soil, all of which contribute to the soil's improved water retaining capacity.

II. RAW MATERIALS

2.1 Agricultural Waste (Leaves of sugarcane)

We will have to use agro-waste material to boost the carbonaceous proportion of the composting. In general, agro-waste is produced by layers of 20cm in height in Aerobic composting, while windrow composting produces layers of 30-40 cm in height in each layer. Shredding machines were used to shred the leaves into little 4-6 cm pieces. The time it takes to decompose a material decreases as particle size decreases.

Figure 1. Shredded agrowaste matrerial

2.2 Green Leaves

A chopper was used to chop the green leaves into little 4-6 cm pieces. It supported the soft bedding and permitted excess water to drain to the bottom of the bin. During the composting process, green leaves increase the nitrogenous material. Maintaining the C/N ratio is beneficial.

Figure 2. Chopped geewn leaves

III. EXPERIMENTAL PROCEDURE

3.1 Plastic Coating

As can be observed, distillery waste wash collected from the sugar industry has higher COD and BOD values than typical ranges of values. To prevent having an adverse effect on soil fertility. We need to apply a plastic coating material on the ground before we can start the field operation.

Figure 1. Palstic Coating Material

3.2 Preparation of bedding

The bin's bottommost layer is made up of agro-waste leaves collected from the sugarcane farm. These are crushed into small pieces using a shredding machine. After that, put a layer of green leaves on top. They are chopped with a chopper, which serves as a drainage media as well as a support for the upper layer. For Aerobic composting, a 20 cm thick layer should be provided, whereas for windrow, a 30-40 cm thick layer should be provided.

Figure 4. Bottom layer of agrowaste

3.3 Monitoring

Bin monitoring involves keeping an eye on moisture content fluctuations and keeping the bin temperature. In all configurations, spent wash was utilized as a nutrient at the start of the experiment. Experimental bins were watered. As a result, effluent was put to the Experimental bins after a three-day delay. To maintain a moisture level of 50-60%, 10-12 litres of water were placed into each pit every day.

3.4 Sampling

To collect samples for analysis, composite sampling was used. Different places were chosen in a container, and samples were taken with a sampling tube. The quartering method was used to get a representative sample from the mixture. Each time, 5-10gm of sample was extracted from each bin.

3.5 Turning

Turning should be done on the 5^{th}, 17^{th}, 30^{th} days & continuously interval for aerobic composting. For windrow composting, it should be provided after 2-4 weeks. The Equipment cum tool used for turning are shown in fig. below,

Figure 5 Equipment cum tool used for turning

IV. DIMENSIONS

4.1 Schematic Diagrams of Aerobic compostingpit

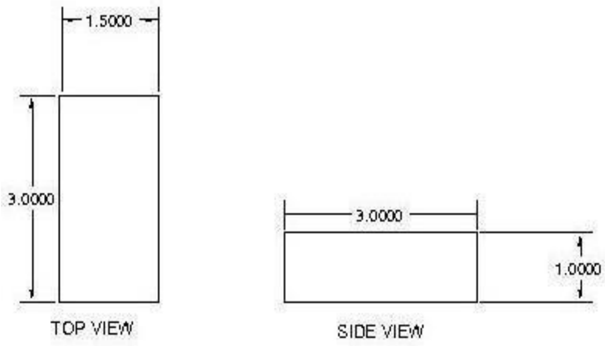

Figure 6 Schematic Diagrams of Aerobic composting pit

4.2 Schematic Diagrams of windorw composting pit

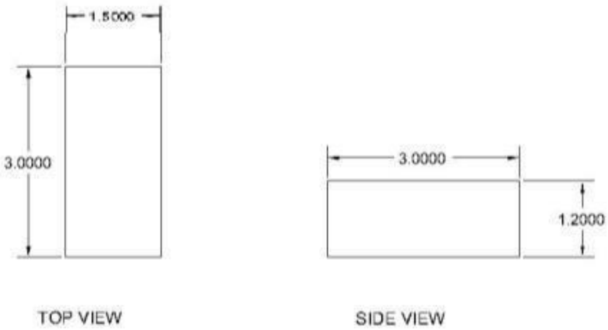

Figure 7 Schematic Diagrams of windorw composting pit

V. RESULTS AND DISCUSSION

5.1 Characteristic of Agro-waste and green leaves

The material which are used as raw material i.e. Agro-waste as a carbonaceous part and Green leaves as a nitrogenous part were characterized. The parametric values should be obtained as,

Table 1 Characteristics of agricultural waste

Parameters	Agro-waste	Green
pH	6.7	6.17
EC (mS/cm)	3.9	3.05
Moisture	15	56.7
Carbon (%)	60	35.7
Nitrogen (%)	0.17	0.35

5.2 Characteristic of spent wash

The analysis reveals that the physicochemical parameters of PTDE (primary treated distillery effluent) contain a considerable load of pollutants. The effluent was a reddish brown colour. The samples had an alcoholic odour. PTDE has very high B.O.D (70,000-90,000 mg/lit) and C.O.D

(1,50,000-2,00,000 mg/lit) ranges due to high organic loading rates in spent wash. Because it's tough to test on a laboratory scale. To test these samples on laboratory scales Depends on B.O.D ranges spent wash is diluted to dilution factors of 75 and 100 (Reference by Metcalf and Eddy, Table no. 3.4).

Table 2 Characteristic of spent wash (D.F=75)

Parameters	Characteristics
pH	7.4
BOD_3 at 27°C	6554.70 mg/l
COD	7680.68 mg/l
TKN	3.57 %
EC	3.05 mS/cm
Hardness	990
DO	3.67 mg/l
P	5.68 %
K	11.57 %

Table 3 Characteristic of spent wash (D.F=100)

Parameters	Characteristics
pH	7.8
BOD_3 at 27°C	3341.78 mg/l
COD	4352.67 mg/l
TKN	2.98 %
EC	2.97 MS/cm
Hardness	946.20
DO	3.98 mg/l
P	4.86 %
K	9.52 %

The results demonstrated a great deal of variation at various effluent dilution levels. PTDE (Primary Treated Distillery Effluent) has the highest values for all physicochemical characteristics. All of the numbers decreased as dilution increased, except dissolved oxygen increased.

5.3 Results Obtained at Turnings

After the 1^{st} turning of composting pits (For Spent wash as a nutrient) the initial results of parameters are obtained are as below shown in table,

Table 4 Results obtained at 1^{st} turn initial phase

Parameters	S_1	S_2
pH	7.5	7.46
EC (mS/cm)	3.18	3.05
M.C (%)	56.45	57.13
TKN(%)	0.78	0.75
Total P(%)	0.53	0.51
Total K(%)	0.49	0.43
TOC(%)	21	23
C/N	26.92	30.66

Where,

S1- Use of Spent wash as a nutrient for Aerobic composting pit.

S2- Use of Spent wash as a nutrient for Windrow composting pit.

After the turnings 2^{nd}, 3^{rd}, 4^{th}, 5^{th} & 6^{th} of composting pits (For spent wash as a nutrient) at intermediate & final phases of result parameters are obtained as below tables as,

Table 4 Results obtained at 2^{nd} turn initial phase

Parameters	S1	S2
pH	7.35	7.12
EC (mS/cm)	3.43	3.95
M.C (%)	52.24	52.38
TKN(%)	0.79	0.78
Total P(%)	0.55	0.53
Total K(%)	0.49	0.45
TOC(%)	18.20	20.05
C/N	23.03	25.70

Table 6 Results obtained at 3^{rd} turn Intermediate phase

Parameters	S_1	S_2
pH	7.09	6.94
EC (mS/cm)	3.99	4.07
M.C (%)	50.92	50.13
TKN(%)	0.85	0.84
Total P(%)	0.57	0.54
Total K(%)	0.52	0.46
TOC(%)	20.03	20.11
C/N	22.50	22.85

Table 7 Results obtained at 4^{th} turn Intermediate phase

Parameters	S_1	S_2
pH	7.03	6.92
EC (mS/cm)	4.02	4.08
M.C (%)	55.89	56.85
TKN(%)	0.85	0.84
Total P(%)	0.57	0.54
Total K(%)	0.55	0.50
TOC(%)	20.07	19.61
C/N	22.50	22.85

Table 8 Results obtained at 5th turn Final phase

Parameters	S_1	S_2
pH	6.99	7.00
EC (mS/cm)	4.04	4.02
M.C (%)	52.30	51.90
TKN(%)	0.89	0.87
Total P(%)	0.59	0.57
Total K(%)	0.58	0.54
TOC(%)	19.32	19.24
C/N	23.00	22.90

Table 9 Results obtained at 6th turn Final phase

Parameters	S_1	S_2
pH	7.00	6.94
EC (mS/cm)	4.03	4.08
M.C (%)	55.89	54.85
TKN(%)	0.93	0.91
Total P(%)	0.64	0.61
Total K(%)	0.61	0.56
TOC(%)	19.21	19.18
C/N	22.08	22.30

At final stage of phase the results of the all parameter values viz. pH, EC, Moisture Content, TKN, P, K & C/N ratio are lies within the limits as per FCO guidelines.

5.4 Graphs

Also pH, electrical conductivity, moisture content, TOC, nitrogen, phosphorous, potassium & C/N ratio parameters of composting were studied. Graphical representation is shown below,

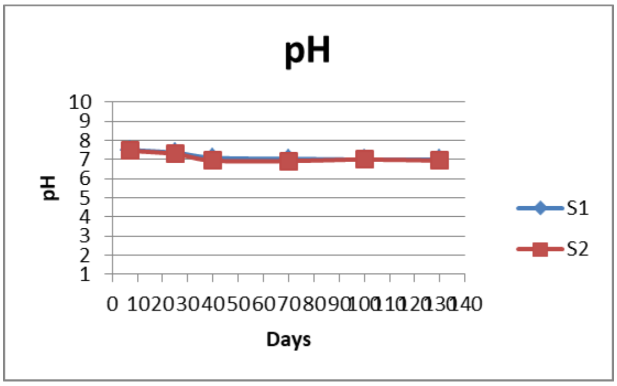

Figure 8 Variation in pH

pH was monitored for all setups as per interval of turning respectively. It was observed that pH at starting phase was high and as process was moving ahead pH was decreasing upto 7 to 6.6 for all combinations. At Initial phases high ranges of pH values was due to neutralization of organic acids.

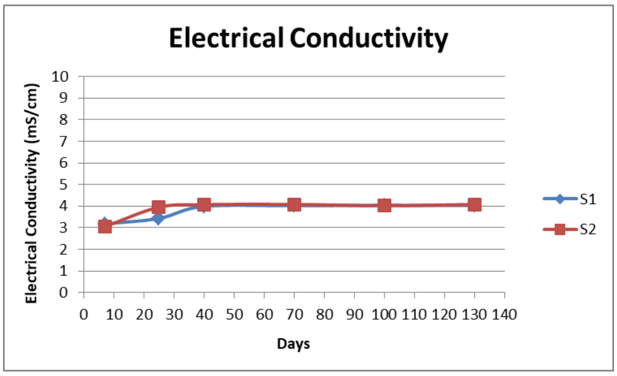

Figure 9 Variation in Electrical Conductivity

Electrical conductivity in compost indicates amount of salts in compost. This salt causes salinity and toxicity to plants due to application of compost of higher electrical conductivity. Electrical conductivity was observed for all setup to be low and within the range. As the process moved ahead Electrical Conductivity increased due to loss of matter and release of mineral salts in available form.

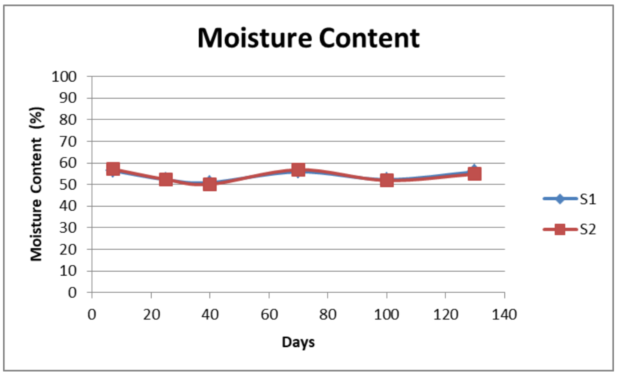

Figure 10 Variation in Moisture Content

Moisture content was used as a control parameter in this overall process of composting. Moisture content is important for survival and growth of micro-organisms. It was maintained at 50-60%. 10-12 litres of water was added in each pit after every 3 days. Watering was stopped when parameters C, N, P, K remained to be constant.

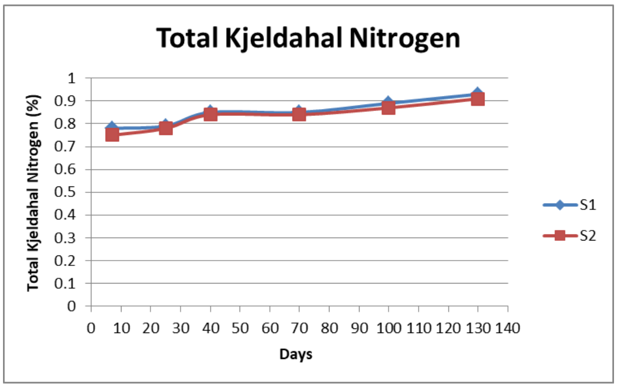

Figure 11 Variation in T. K. N

Nitrogen content is high in green leaves (grass) and low in dry leaves. Also its present in an wastewater which are used as an nutrients during composting processes. Nitrogen is important because it contains enzymes, co-enzymes, proteins, amino acids and nucleic acids required for growth of microbial cells. In all setups where spent-wash used as an nutrient it shows higher ranging values of nitogen content as that of municipal wastewater as an nutrient.

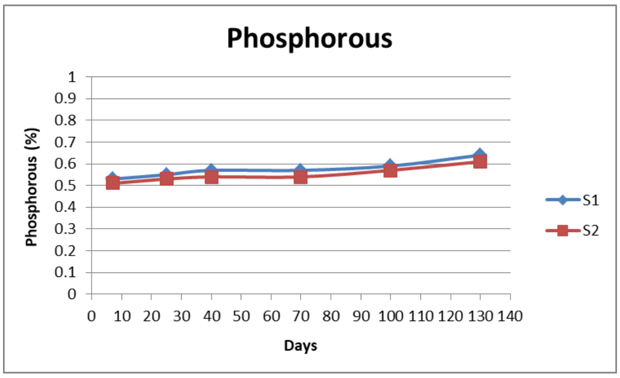

Figure 12 Variation in Phosphorous

Phosphorous is important component required for acculumation and release of energy related to root and seed formation, crop growth and to enhance the crop production in agriculture. Determination of phosphorous in compost is essential for providing proper amount of nutrients for health and growth of plants. Phosphorous in compost is observed to be increased throughout the composting process and it is analyzed in Phosphorous Pentoxide form (P_2O_5).

Observation for all setups were in spent-wash used as an nutrient showed higher increase in phosphorous ranges. All setups had phosphorous more than 0.4%, according to FCO standards (1985) it was within the range.

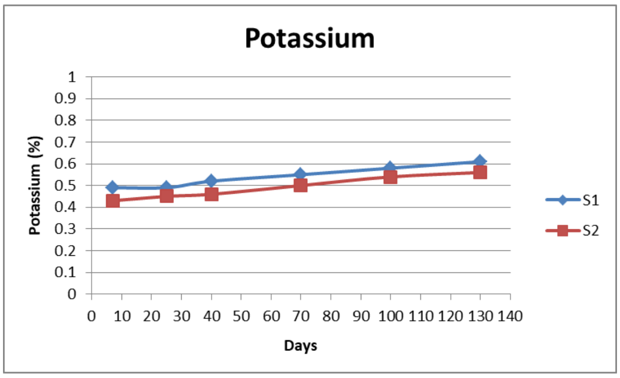

Figure 13 Variation in Potassium

Potassium plays an important role as a plant nutrient for proper growth of plants. Potassium affects size, shape, color, taste and health of plants. Potassium (K) in compost is observed to increase throughout the composting process and is analyzed for its K_2O form.

Potassium was increasing in all pits, which seen that graph it shows that where spent-wash used as an nutrient having high ranging values.

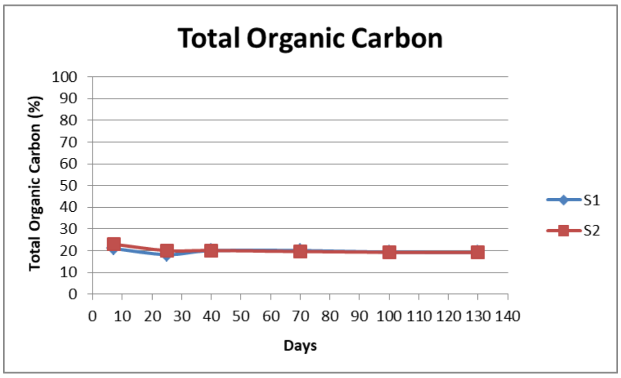

Figure 14 Variation in T.O.C

TOC indicates organic or biodegradable content in compost. TOC at beginning of maturation is high and reduces. TOC in mature compost should be more than 12% according to FCO standards (1985), for its land application. For the work conducted, all setups showed decrease in initial phases onwards it showed constant ranging values between 19%. TOC showed within the ranging values for all setups.

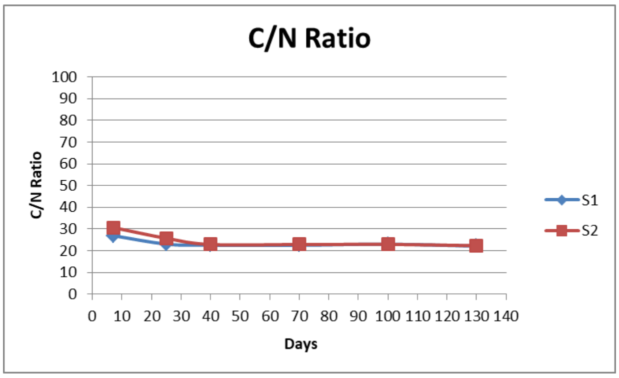

Figure 15 Variation in C/N Ratio

Nutrients like C, N, P and K are maintained to breakdown of organic matter and obtain energy. Among this nutrients C and N are important because C is source of energy for microbes and nitrogen is required for building the cell structure of microbes. Lower C/N ratio results in decrease in microbial growth, leading to slower decomposition of carbon and whereas excess amount of C/N results in volatiization of ammonia gas. Carbon is lost in form of CO_2 after its oxidation and nitrogen increase during composting. It is observed that bulking agents such as dry leaves can be use to enhance C/N ratio and porosity of the compost. Completely matured compost indicates lower C/N ratio.

C/N ratio was seen in decreasing order in all setups. All setup showed the result which were within the range of 20 to 30, according to FCO standards (1985).

Table 10 Comparison of qualities result obtained at composting site with compost available in market

Parameters	S_1	S_2	L_1
pH	7.00	6.94	7.62
EC (mS/cm)	4.03	4.08	3.34
M.C (%)	55.89	54.85	27.45
TKN(%)	0.93	0.91	0.91
Total P(%)	0.64	0.61	0.49
Total K(%)	0.61	0.56	0.43
TOC(%)	19.21	19.18	17.25
C/N	22.08	22.30	18.95

Where, L_1 = Compost Available in Local Market.

For the comparison purpose we have taken a compost available in local market. The aim of study is to compare quality and cost of that product on site and available in local market were analyzes.

VI. DISCUSSION

The soil is the primary source of the necessary elements, which are absorbed and accumulated in the bodies of vascular plants before being made available to the ecosystem's other living organisms. Because of the lack of supply of these elements in croplands nitrogen, phosphorus, and potassium are added as fertilisers. The difference between a natural and a man-made ecosystem is that in the former, the soil nutrient status is maintained through natural biogeochemical cycling, whereas in the latter, a significant proportion of the soil nutrients removed by the plants does not reach the crop field. So that Chemical fertilisers, organic manure, and spent wash irrigation are used to keep the soil's nutritional status at a suitably high level for a productive yield.

VII. CONCLUSION

We can conclude from the findings that it can transform a large volume of garbage in a shorter amount of time. Also whatever results are obtained their it shows finally good with having N= 0.75 to 1%, P=0.3 to 0.75 percent, and K=0.3 to 0.75 percent are inferior product. Even production costs are lower than the compost purchased from a local store.

The compost purchased from a local store obtained at cost 185 rupees per kilogram, whereas compost made on site gets obtained at costs of 121 rupees per kilogram. The compost which are prepared on site shows dark brown to black in colour and has no bad odour. Also Minimum 60% of material should passed through 4 mm IS Sieve.

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