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Physico chemical analysis of Municipal Solid Waste (MSW) dumping yard soil from Tuticorin City

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Abstract

This research paper deals with the physico-chemical characteristics of municipal solid waste (MSW) dumping site soil in Tuticorin city. The characteristics of MSW dumped soil, i.e., pH, electrical conductivity, micronutrients (Fe, Mn, Zn, Cu) and macronutrients (N, P, K) were evaluated. The use of MSW as vermicompost offers a unique opportunity for economical disposal. Loss of biodiversity can be observed due to open dumping of solid waste. Accumulation of hazardous substances is the common phenomenon in open dumping of MSW. It affects the food chain and food web. It's a very dangerous effect later on. The dumping site always surrounded by scavenging animals and such unwanted things along with the strong odour. The analysis of MSW dumping site soil indicates that it is good source of nutrients for the agriculture sector. On the basis of result MSW compost can be recommended to the farmers.

Keywords: Municipal Solid Waste, Physico chemical analysis, Tuticorin

Introduction

During the present research Tuticorin city from Tamilnadu state was selected as a study area to study the physico-chemical characterizations of municipal solid waste (MSW) dumping yard soil. Tuticorin is one of the important, rapidly growing city from Tamilnadu state of India. The area of the district is 4621 Sq.k.m. and the population is 1738376 (as per 2011 census). The Tuticorin city generates solid wastes of about 110 metric tonnes per day, i.e. a per capita solid waste of about 500 grams per day. The solid waste clearance is managed both

by the corporation and private contractors and is not adequately mechanized. The performance efficiency is about 50% (www.municipalities.tn.in).

The solid waste collected is transported to a compost yard at Tharuvaikulam, about 12 km away from the city and the yard does not have facilities for segregation of the mixed waste, waste processing, leveling and compaction. This, therefore, creates environmental hazards. Compliance with the Municipal Solid Waste (Management and Handling) Rules, 2000 is inadequate in collection, storage, transportation and disposal. According to the Rules, municipal bodies must make it mandatory for households/industries to segregate and store waste at source till collection by the corporation. The rules also prescribe the practices to be followed for vermicomposting of biodegradable wastes and anaerobic digestion or any other appropriate biological processing for the stabilization of wastes.

Dumping of MSW leads to change in following characterizations of soil Odour, Ground water pollution, Permeability, Bearing capacity, Porosity, Degree of saturation, Alkalinity, pH, Micronutrients and Macronutrients. The above mentioned changes are adverse by agricultural point of view. This decreases the fertility of soil. Dumping of solid waste, destructs the habitat of beneficial microorganisms due to change in chemical environment. It can be observed by the odour coming from the soil after water sprinkled. Loss of biodiversity can be observed in open dumping site area. Accumulation of hazardous substances is the common phenomenon in open dumping of MSW. It affects the food chain and food web. It's a very dangerous effect later on. The dumping site always surrounded by scavenging animals and such unwanted things along with the strong odour (Dwivedi *et al* 2014).

Physico-chemical characterizations of micro and macro nutrients of compost soil have been performed for MSW soil, to assess its quality for applying as soil conditioner to promote the growth of earthworm. Earthworm was important contributor to the soil decomposer. The present study was undertaken with the following objectives

- We recommend to avoid open dumping of municipal solid waste
- Assessment of municipal solid waste dumping site soil characteristics
- Suggestions for cost effective better management of MSW by earthworms
- We propose MSW as a bio fertilizer

Material and Methods

Study Area

Tuticorin Corporation has 534 acres compost yard at Tharuvaikulam 12 kms away from Tuticorin. The solid wastes collected from 58 wards and shifted to compost yard. Soil collection site named as S1, S2 and S3 (Table 1).

Sampling

Sampling is the important stage in physico-chemical analysis of MSW dumping site soil analyses. The results produced are very accurate, only if the sampling stages should be carried out in a systematic manner and as per the standard procedures for soil. The test portion is made representative because the final result is completely dependent on the sampling. Sampling includes site selection, sample volume, sample preservation, sampling devices, preservation at site, transport to laboratory and preservation in laboratory before analysis.

Soil Sampling

The aim of soil sampling is to obtain a small portion of the sample that accurately represents the characteristics of the particular location being sampled. Less quantity of soil sample is actually used for the laboratory analysis. That small amount of soil must represent the entire area for which the recommendation to be made. This is referred to as taking a representative sample and is vitally important because the conclusions derived that are ultimately drawn from the data obtained from the analysis. For authentic report, representative soil sample is essential for soil testing to find out the contamination and its estimation. Therefore, to take accurate soil sample, a proper methodology with clear objective, time, depth and tools were followed (IS:2720 (1983)).

Soil Sample collection at site

Soil sample collection site locations were fixed previously. Depending upon the soil texture the soil sampling tools were selected. Tube auger and spade were used for soft and moist soil. Screw auger was used for hard and dry soil. Sampling equipment was cleaned with water initially and wiped with clean cotton cloth. Sampling site was cleaned properly by scrapping the litter and plant parts from the soil surface. Generally the sample digging was done in such

a way that V-shape hole was made and cut out a uniformly thick 2.5cm slice of soil from bottom to top of the exposed surface. Random collection of soil sample from each unit at desired depth from 3 spots separately in a field is known as primary sample.

The seasonal variation survey of aged soil was conducted around Tuticorin Corporation solid waste dumping site area from June-2011 to May-2012. Three samples of aged soils were collected in each season (post-monsoon, summer, pre-monsoon and monsoon). All samples were coded. For aged soil samples the codes are given as S1 to S3. Three aged soil samples were collected in and around the compost site.

Aged soils were collected from three different sites in the compost yard at Tharuvaikulam. Aged soil samples were collected from the top 15 cm layer of the sampling stations. Prior to collection, top layer soils were hand sorted and plant materials as well as litter were carefully removed from the soil. About 500 g of aged soil were taken in individual labeled sterile polythene bags from three sites.

Preparation of soil sample

Soil samples were air dried in shade by spreading on plastic sheets. They were cleaned by discarding plant residues, gravels, coarse materials, stones and other debris if present. The cleaned soil samples were stored in a clean polythene bag. The soil samples were labeled immediately in the form of tags to prevent sample misidentification and given a unique sample number, sampling code, sampling time and special note if any.

Soil Sample Laboratory Analysis

The physico-chemical characteristic of the aged soil was analyzed, from Kovilpatti agriculture soil testing laboratory. pH, such as several parameters micronutrients (Fe,Mn,Zn,Cu), macronutrients (N,P,K), soil texture, calcium carbonate, were analyzed.

Result

In the present study the micro and macro nutrients were analysed for better management of municipal solid waste in Tharuvaikulam of Tuticorin city. The study areas were designated as S1, for Tharuvaikulam main gate, S2, for Tharuvaikulam second gate, S3, for Tharuvaikulam third gate were selected (Table 1). Table 1 revealed the presence of different soil samples of Tuticorin municipal solid waste. The physico-chemical characteristics and essential nutrient

sample collected from different sites and different stages such as Pre-Monsoon, Winter, Monsoon and Post-Monsoon season were listed in Table 2.

In the present study, the study area S1 was found to be moderate with salinity expressed as dsm^{-1}, observed during the month of July 2011 to June 2012 (12 months). Among the 3 different study area namely S1, S2 and S3. S2 exhibited a constant increase in salinity in soil were recorded, where as S3 exhibited 0.4 observed during the month of June followed by a constant decrease in salinity with 2.5 observed during the month of July. It is then found to decrease in salinity gradually (Table 3 & 4).

The pH of the municipal solid waste soil was found to be slightly basic in pre-monsoon followed by an enhanced basic pH in monsoon period. It is observed that similar pattern of pH in site 2 Tharuvaikulam was recorded but during monsoon period a basic pH was constantly maintained. However, during the month of January, February and March pH was found to be increased with 8.46 observed for site 2. This indicated during monsoon, due to heavy rainfall there is a gradual change in salinity which may lead to a change in pH. In site 3 the pH was found to be slightly above the neutral during the month of June, July and August. In monsoon period a slight increase in pH with 8.81, 8.28, 8.42 followed by pH of 7.58 was recorded during the month of January, February and March (Table 3 & 4).

The micronutrient present in the Tuticorin corporation dumping site soil analysed for the month of July, 2011, Fe content ranges from 6.83 ± 0.02, 12.79 ± 0.06 and 5.57 ± 0.02 mg recorded for S1, S2, S3 respectively, where as Mn ranges from 3.75 ± 0.02 to 3.44 ± 0.04 mg, Zn ranges from 9.97 ± 0.02 to 25.15 ± 0.04 mg and the heavy metal Cu ranges from 3.35 ± 0.05, 5.97 ± 0.02 and 4.82 ± 0.02 mg observed for S1, S2 and S3. The macronutrients recorded for N, P, K was determined for the month of July, 2011. It was observed that nitrogen content was found to be 171.67 ± 0.58,171.67 ± 1.53 and 172 ± 1.0 mg/kg recorded for site S1, S2 and S3 respectively, where as the phosphorous ranges from 8.57 ± 0.21 to 9.13 ± 0.15 mg/kg in the case of phosphorous for different sites. The level of potassium was found to be with 499.33 ± 1.15,500 ± 1.0, 499.63 ± 2.52 mg/kg recorded for site S1, S2 and S3 respectively.

Studies carried out with micronutrient analysis observed during the month August revealed 5.73 ± 0.02, 10.63 ± 0.02 and 4.74 ± 0.02 mg recorded for the presence of Fe content in different locations such as S1, S2 and S3. However analysis of Mn during the month of August exhibited a range of from 4.57 ± 0.03, 4.86 ± 0.03 and a decline of 4.35 ± 0.03 mg was noted. Analysis for Zn was found in ranges from 8.17 ± 0.02, 9.36 ± 0.02 and 10.16 ± 0.02 mg,

Cu revealed a range of from 2.55 ± 0.04, 4.54 ± 0.02 and 8.91 ± 0.02 mg observed for S1, S2 and S3 respectively, for the month of August, 2011. The macronutrients recorded for N, P, K was determined for the month of August, 2011. It was observed that nitrogen content was found to be 172.33 ± 1.53 mg/kg to 173 ± 1.0 mg/kg where as the phosphorous ranges from 9.13 ± 0.15 to 7.57 ± 0.35 mg/kg in the case of phosphorus for different sites. The level of potassium was found to be with 500.33 ± 0.58, 502.33 ± 2.08 and 498.67 ± 1.53 mg/kg recorded for site S1, S2 and S3 respectively.

In a similar study with micronutrients analysis during the month September revealed 2.04 ± 0.03 , 6.95 ± 0.02 and 3.18 ± 0.01 mg were recorded for the presence of Fe content in different locations such as S1, S2 and S3. The analysis for Mn during the month of September varied with a range of from 0.94 ± 0.03, 0.18 ± 0.01 and 0.38 ± 0.01 mg. The analysis for Zn was found to be from 13.14 ± 0.02, 24.68 ± 0.03 and 13.14 ± 0.02 mg, Cu ranges from 0.29 ± 0.01, 0.48 ± 0.02 and 0.16 ± 0.02 mg observed for S1, S2 and S3 respectively, for the month of September, 2011. The macronutrients recorded for N, P, K was determined for the month of September, 2011. It was observed that nitrogen content was found to be range from 90 ± 1.0 to 135.67 ± 1.53 mg/kg. However range of phosphorous exhibited from 8.5 ± 0.01 to 11.63 ± 0.15 mg/kg in the case of phosphorus for different sites. The level of potassium was found to be range from 501 ± 1.0 to 341.67 ± 1.53 mg/kg recorded for site S1, S2 and S3 respectively.

Moreover, studies made with micronutrient analysis carried out during the month October 2011 revealed 6.77 ± 0.02, 4.54 ± 0.03 and 5.45 ± 0.03 mg were recorded for the presence of Fe content in different locations such as S1, S2 and S3. The analysis for Mn during the month of October range from 0.26 ± 0.02, 0.82 ± 0.02 and 1.24 ± 0.02 mg. The analysis for Zn range from 21.84 ± 0.03, 19.45 ± 0.03 and 18.35 ± 0.04 mg, where as Cu range from 0.25 ± 0.02, 0.24 ± 0.02 and 0.26 ± 0.02 observed for S1, S2 and S3 respectively, for the month of October, 2011. The macronutrients recorded for N, P, K determined for the month of October, 2011. It was observed that nitrogen content was found to be decreased from 172.33 ± 1.53 to 84.67 ± 1.15 mg/kg where as the phosphorous range also differ from 11.6 ± 0.2 to 9.13 ± 0.15 mg/kg in the case of phosphorus for different sites. The level of potassium was found to be with 203 ± 2.0, 361.33 ± 1.53 and 508.67 ± 1.53 mg/kg recorded for site S1, S2 and S3 respectively.

Simultaneously, study was carried out for micronutrients analysis during the month November 2011 revealed 2.45 ± 0.02, 2.45 ± 0.03 and 2.35 ± 0.03 mg were recorded for the presence of Fe content in different locations such as S1, S2 and S3. Analysis for Mn during

the month of November ranges from 3.32 ± 0.02, 3.36 ± 0.02 and 3.37 ± 0.02 mg. The analysis for Zn ranges from 1.19 ± 0.01, 1.16 ± 0.03 and 1.15 ± 0.03 mg, Cu ranges from 1.24 ± 0.01, 1.27 ± 0.02 and 1.27 ± 0.03 mg observed for S1, S2 and S3 respectively, for the month of November, 2011. The macronutrients recorded for N, P, K was determined for the month of November, 2011. It was observed that nitrogen content was found to be 116.33 ± 1.53 to 171 ± 1.0 mg/kg where as the phosphorous range from 9.3 ± 0.2 to 9.13 ± 0.15 mg/kg, in the case of phosphorus for different sites. The level of potassium was found to be 419.6 ± 1.53, 451.33 ± 1.53 and 499.67 ± 1.53 mg/kg recorded for site S1, S2 and S3 respectively.

In another study with micronutrient analysis recorded during the month December 2011 revealed 5.44 ± 0.03, 5.23 ± 0.02 and 6.05 ± 0.02 mg were recorded for the presence of Fe content in different locations such as S1, S2 and S3. The analysis for Mn during the month of December range from 1.95 ± 0.02, 1.82 ± 0.02 and 1.82 ± 0.02 mg. The analysis for Zn range from 10.16 ± 0.05, 12.33 ± 0.03 and 10.28 ± 0.02 mg. Moreover Cu range from 0.25 ± 0.03, 0.26 ± 0.02 and 0.26 ± 0.01 mg observed for S1, S2 and S3 respectively, for the month of December. The macronutrients recorded for N, P, K was determined for the month of December, 2011. It was observed that nitrogen content was found to be increased from 116 ± 2.0 to 153 ± 2.0 mg/kg where as the phosphorous ranges from 7.4 mg/kg. Similarly, phosphorus exhibited a value of 7.37 ± 0.15, 6.87 ± 0.06 and 7.43 ± 0.15 mg for different sites. The level of potassium was found to be 286.67 ± 1.53, 498.67 ± 1.53 and 206.33 ± 1.53 mg/kg recorded for site S1, S2 and S3 respectively.

The analysis of micronutrient observed during the month January 2012 revealed 6.13 ± 0.02, 5.95 ± 0.02 and 5.72 ± 0.03 mg were recorded for the presence of Fe content in different locations such as S1, S2 and S3. The analysis for Mn during the month of January range from 1.85 ± 0.02, 1.77 ± 0.02 and 1.84 ± 0.04 mg. The analysis for Zn varied from 11.74 ± 0.02, 12.53 ± 0.04 and 12.05 ± 0.03 mg, However Cu range was found to be from 0.38 ± 0.02, 0.26 ± 0.02 and 0.32 ± 0.02 mg observed for S1, S2 and S3 respectively, for the month of January, 2012. The macronutrients recorded for N, P, K was determined for the month of January, 2012. It was observed that nitrogen content was found to be 96 ± 1.0 to 142 ± 2.65 mg/kg where as the phosphorous range from 5.77 ± 0.15 to 7.3 ± 0.1 mg/kg in the case of phosphorus for different sites. The level of potassium was found to be with 498.67 ± 1.53,499 ± 1.0 and 498.67 ± 1.53 mg/kg recorded for site S1, S2 and S3 respectively.

Simultaneously, in a similar study with micronutrient analysis during the month February revealed 6.77 ± 0.02, 7.07 ± 0.03 and 7.13 ± 0.02 mg recorded for the presence of Fe content in different locations such as S1, S2 and S3. The analysis for Mn during the month of February range from 1.94± 0.02, 1.63± 0.03 and 1.85± 0.02 mg. The analysis for Zn range from 12.14 ± 0.02, 11.17 ± 0.03 and 11.83 ± 0.02 mg respectively, Cu range from 0.47 ± 0.03, 0.53 ± 0.02 and 0.64 ± 0.03 mg observed for S1, S2 and S3 respectively, for the month of February, 2012. The macronutrients recorded for N, P, K was determined for the month of February, 2012. It was observed that nitrogen content was found with value of 136 ± 1.0,127 ± 1.0 and 136 ± 2.0 mg/kg where as the phosphorous range increase from 12.67± 0.25 to 13.17± 0.21 mg/kg in the case of phosphorus for different sites. The level of potassium was found to have values as 498.33 ± 2.08, 498.67 ± 1.53 and 499 ± 1.0 mg/kg recorded for site S1, S2 and S3 respectively.

The micronutrient analysis studied made with micronutrients analysis during the month March revealed 7.84 ± 0.03, 6.94 ± 0.03 and 7.12 ± 0.02 mg, recorded for the presence of Fe content in different locations such as S1, S2 and S3. The analysis for Mn during the month of March ranges from 1.74 ± 0.02, 1.84 ± 0.02 and 1.75 ± 0.03 mg. The analysis for Zn range from 12.12 ± 0.03, 11.82 ± 0.02 and 12.13 ± 0.02 mg. Whereas, Cu range from 0.69 ± 0.01, 0.56 ± 0.02 and 0.84 ± 0.03 mg observed for S1, S2 and S3 respectively, for the month of March, 2012. The macronutrients recorded for N, P, K was determined for the month of March, 2012. It was observed that nitrogen content was found to be 132.33 ± 1.53, 122 ± 2.65 and 130 ± 1.0 mg/kg where as the phosphorus ranges from 13.4 ± 0.2 to 10.5 ± 0.2 mg/kg in the case of phosphorus for different sites. The level of potassium was found to be range from 498.67 ± 1.53 to 450.33 ± 1.53 mg/kg recorded for site S1, S2 and S3 respectively.

The micronutrient analysis studied made with micronutrients analysis during the month April 2012 revealed 17.37 ± 0.31, 19.7 ± 0.61 and 14.53 ± 0.5 mg, recorded for the presence of Fe content in different locations such as S1, S2 and S3. The analysis for Mn during the month of April ranges from 5.79 ± 0.35, 6.6 ± 0.26 and 8.63 ± 0.25 mg. The analysis for Zn range from 17.56 ± 0.23, 20.71 ± 0.29 and 11.66 ± 0.27 mg. Whereas, Cu range from 17.73 ± 0.32, 15.55 ± 0.37 and 6.44 ± 0.11 mg observed for S1, S2 and S3 respectively, for the month of April, 2012. The macronutrients recorded for N, P, K was determined for the month of April, 2012. It was observed that nitrogen content was found to be 154.2 ± 1.24, 142.2 ± 0.33 and 141.46 ± 0.44 mg/kg where as the phosphorus ranges from 5.77 ± 0.23 to 4.82 ± 0.1 mg/kg in the case of phosphorus for different sites. The level of potassium was found to be range from 496.61 ± 0.54 to 496.15 ± 0.82 mg/kg recorded for site S1, S2 and S3 respectively.

Simultaneously, in a similar study with micronutrient analysis during the month May 2012 revealed 18.2 ± 0.3, 20.07 ± 0.24 and 15.69 ± 0.6 mg recorded for the presence of Fe content in different locations such as S1, S2 and S3. The analysis for Mn during the month of May range from 5.97± 0.21, 6.82± 0.11 and 8.84 ± 0.09 mg. The analysis for Zn range from 17.85 ± 0.08, 20.48 ± 0.18 and 12.17 ± 0.34 mg respectively, Cu range from 17.16 ± 0.71, 15.78 ± 0.35 and 6.39 ± 0.42 mg observed for S1, S2 and S3 respectively, for the month of May, 2012. The macronutrients recorded for N, P, K was determined for the month of May, 2012. It was observed that nitrogen content was found with value of 154.09 ± 1.02, 140.88 ± 0.82 and 139.12 ± 0.9 mg/kg where as the phosphorous range increase from 4.67± 0.42 to 3.9± 0.1 mg/kg in the case of phosphorus for different sites. The level of potassium was found to have values as 495.2 ± 1.13, 495.77 ± 1.07 and 494.57 ± 4.0 mg/kg recorded for site S1, S2 and S3 respectively.

The physico-chemical characteristics of soil pertaining to micronutrients and macronutrient analysis were found for different location and in different seasons. The micronutrients present in the site S1, Iron (Fe) content varied from a range of 17.1 ± 0.3, 20.43 ± 0.21 and 14.7 ± 0.38 mg recorded for S1, S2, S3 respectively. Whereas, Mn varied from 5.47 ± 0.35 to 8.53 ± 0.31 mg, Zn ranges from 17.37 ± 0.38 to 11.27 ± 0.38 mg and the heavy metal Cu was found to be 17.37 ± 0.35, 15.3 ± 0.44 and 6.03 ± 0.38 mg observed for S1, S2 and S3. The macronutrients are recorded for Nitrogen (N), Phosphorus (P), Potassium (K) was determined for the month of June, 2012. It was observed that nitrogen content was found to decrease with 153.67 ± 5.51 to 141.4 ± 0.3 mg/kg where as the phosphorous ranged from 5.5 ± 0.3 to 4.5 ± 0.36 mg/kg in the case of phosphorous for different sites. The level of potassium was found to be 419.67 ± 4.04, 451.33 ± 3.79 and 499.67 ± 3.51 mg/kg recorded for site S1, S2 and S3 respectively.

Table: 1 Exhibit Study Area

Site Code	Location	Area (acres)	Use
S1	Tharuvaikulam GDY Main Gate	534	Garbage dumping
S2	Tharuvaikulam GDY 2^{d} Gate	534	Garbage dumping
S3	Tharuvaikulam GDY 3^{d} Gate	534	Garbage dumping

Note: GDY - Garbage dumping yard

Table: 2 Different Stages of Climatic season

Season	Months
Pre-Monsoon	July, August, September
Winter	October, November, December
Monsoon	January, February, March
Post Monsoon	April, May, June

Table: 3 Physical Characteristics of Municipal Solid Waste Dumping Site Soil during Pre-Monsoon and Winter

Season	Pre-Monsoon			Winter		
Parameter	**Jul-11**	**Aug-11**	**Sep-11**	**Oct-11**	**Nov-11**	**Dec-11**
pH						
S1	7.72±0.04	7.84±0.03	8.05±0.06	7.73±0.02	8.22±0.03	7.5±0.02
S2	7.72±0.03	8.14±0.04	8.12±0.02	8.33±0.04	8.64±0.03	8.16±0.04
S3	7.93±0.03	7.72±0.02	8.23±0.05	8.82±0.03	8.28±0.03	8.43±0.04
EC (dSm^{-1})						
S1	0.96±0.05	0.95±0.06	0.39±0.05	0.37±0.07	0.39±0.03	0.27±0.03
S2	1.06±0.12	0.69±0.04	0.28±0.04	0.29±0.03	0.45±0.03	0.57±0.04
S3	2.14±0.32	0.86±0.09	0.17±0.04	0.56±0.07	0.45±0.05	0.28±0.03

Table: 4 Physical Characteristics of Municipal Solid Waste Dumping Site Soil during Monsoon and Post-Monsoon

Season	Monsoon			Post-Monsoon		
Parameter	**Jan-12**	**Feb-12**	**Mar-12**	**Apr-12**	**May-12**	**Jun-12**
pH						
S1	8.64±0.04	8.09±0.04	8.22±0.09	7.67± 0.06	7.57± 0.21	7.65±0.04
S2	8.55±0.06	7.79±0.26	8.48±0.03	7.7± 0.1	7.57± 0.15	7.83±0.03
S3	8.37±0.06	8.64±0.32	7.53±0.05	7.57± 0.15	7.57± 0.21	7.91±0.06
EC (dSm^{-1})						
S1	0.56±0.06	0.27±0.03	0.34±0.03	0.44± 0.02	0.44± 0.01	0.45±0.04
S2	0.35±0.04	0.18±0.04	0.18±0.06	0.46± 0.03	0.44± 0.03	0.45±0.05
S3	0.39±0.03	0.45±0.05	0.36±0.02	0.45± 0.03	0.43± 0.02	0.41±0.02

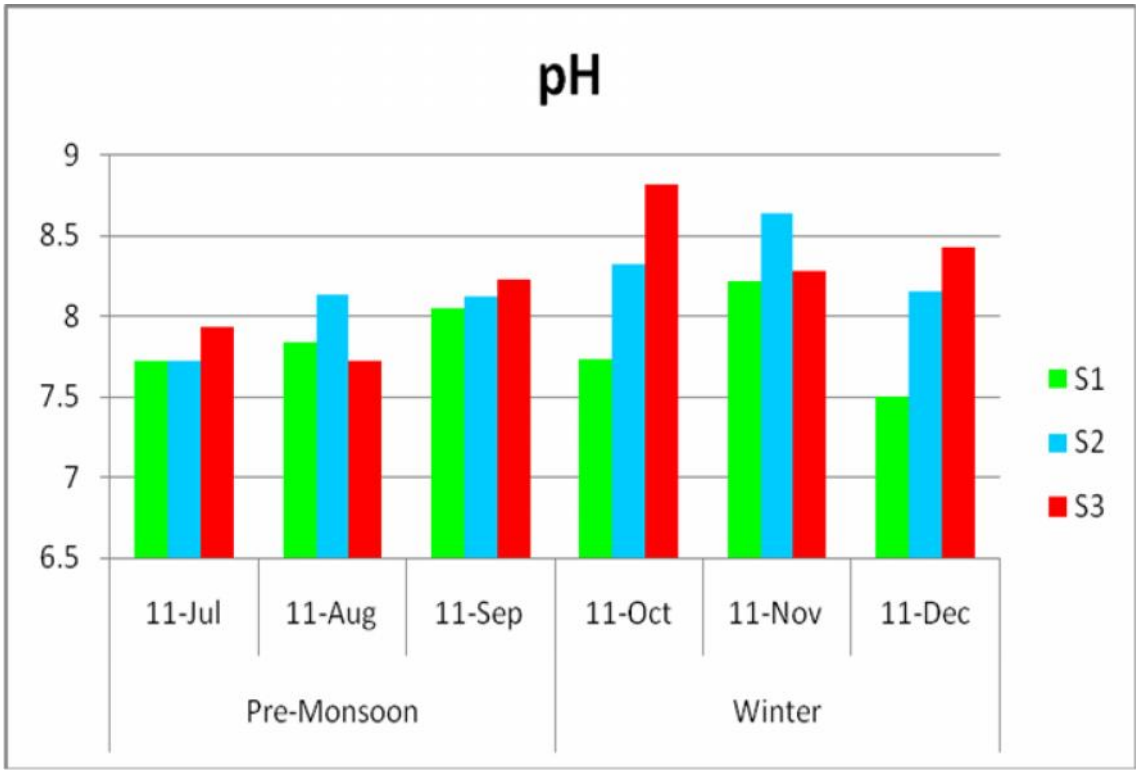

Fig: 1 Seasonal variation in pH

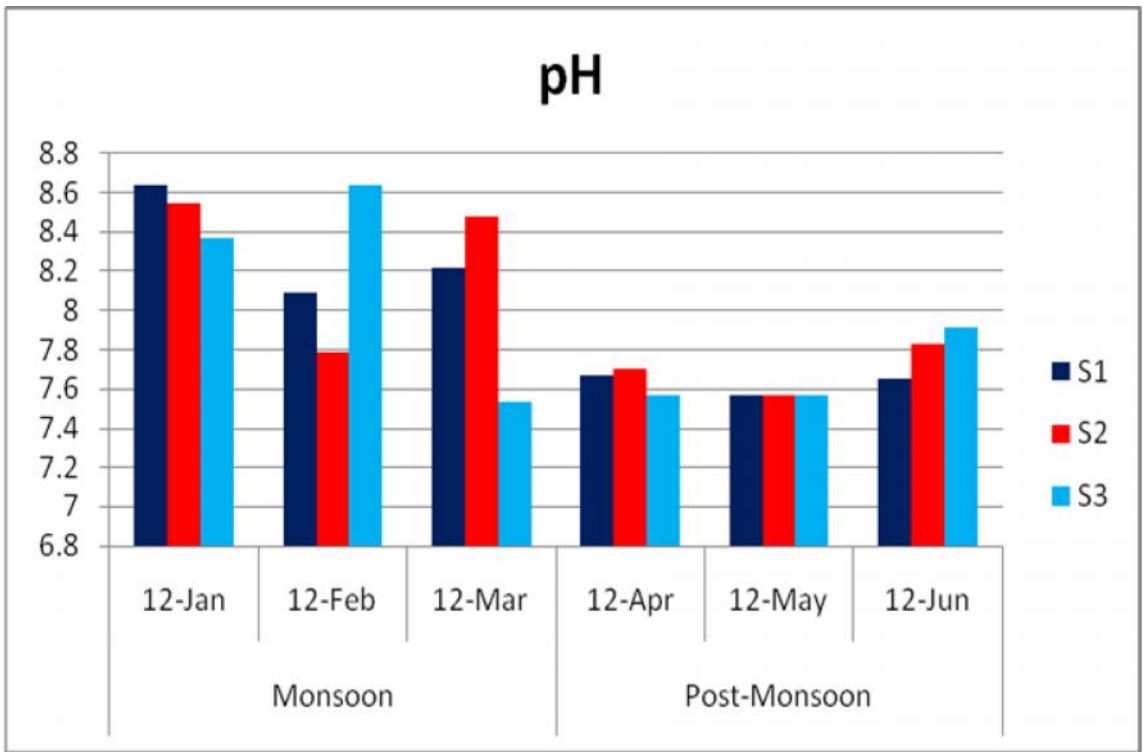

Fig: 2 Seasonal variation in pH

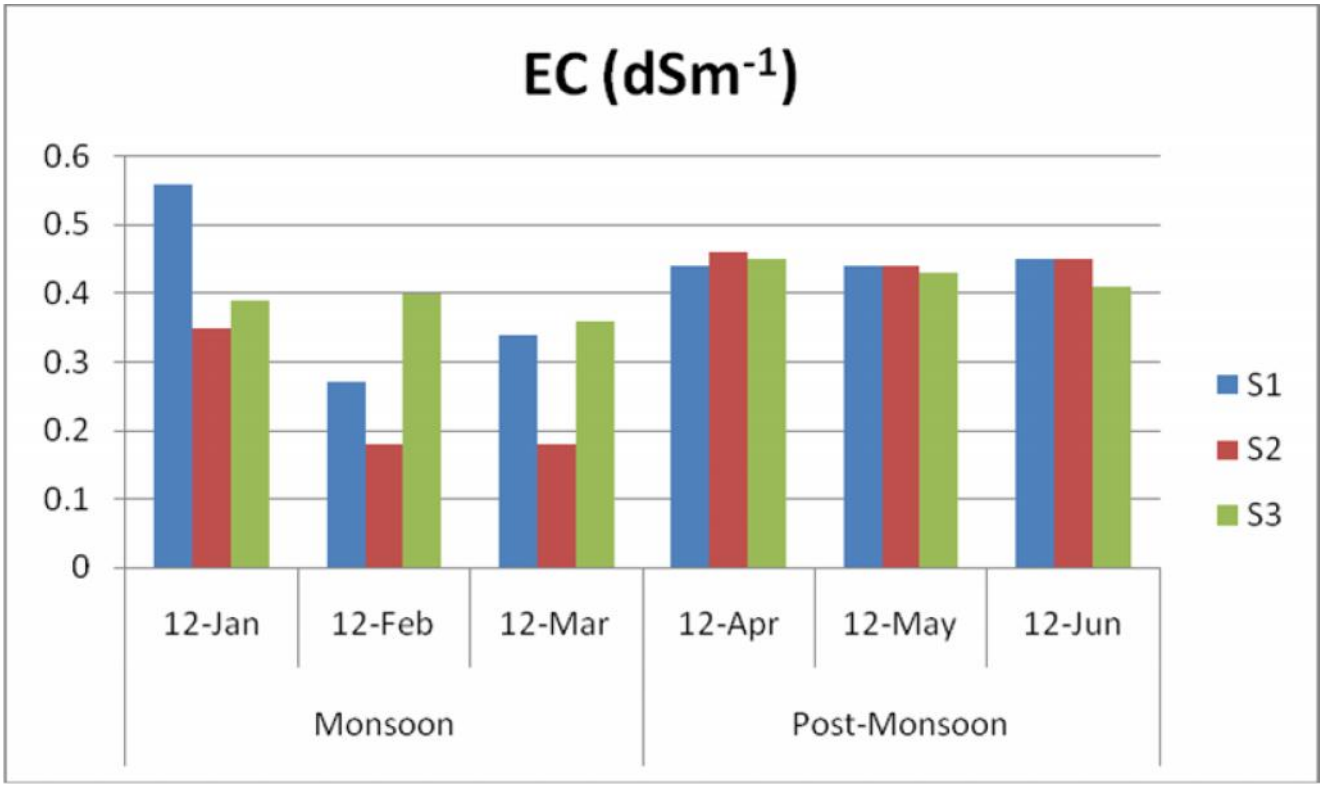

Fig: 3 Seasonal variation in EC

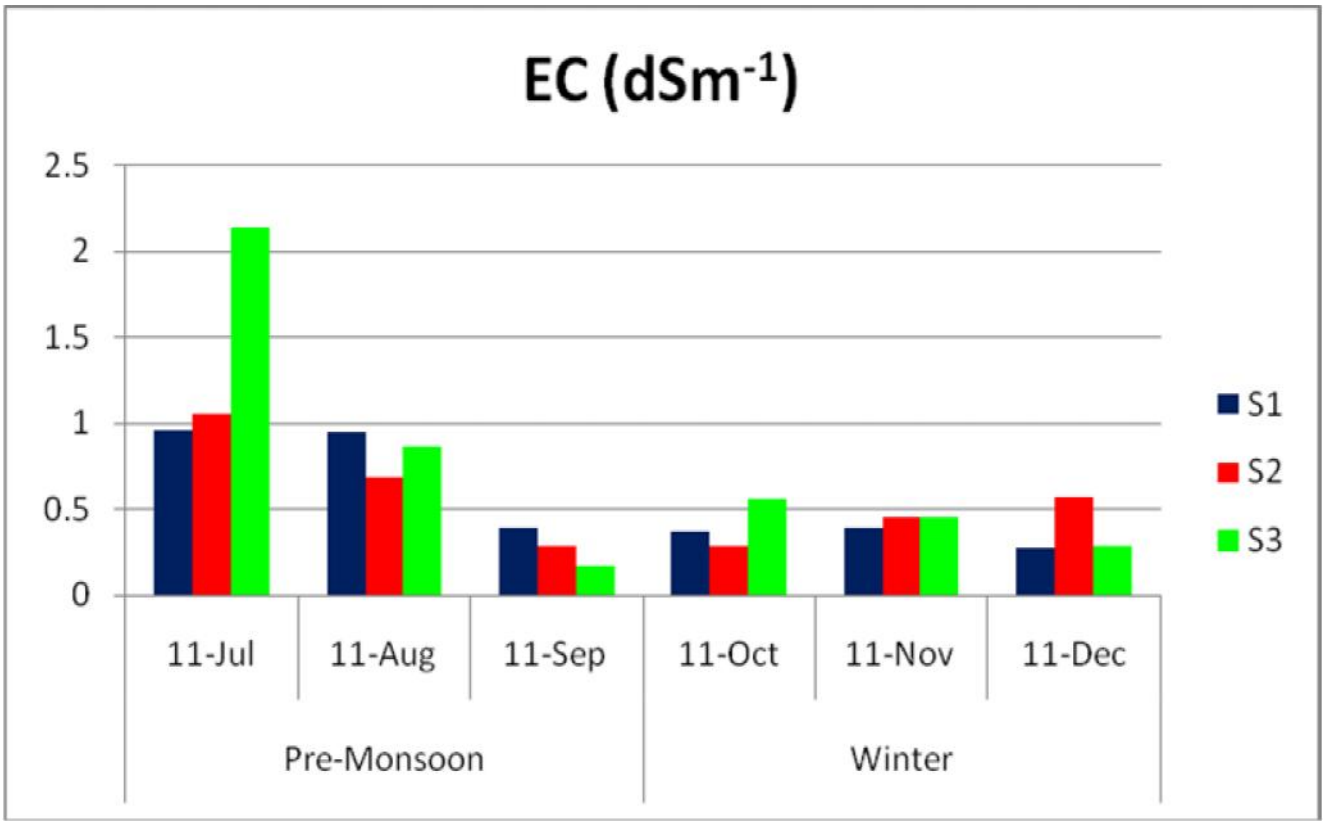

Fig: 4 Seasonal variation in EC

Table 5: Chemical Characteristics of soil from municipal solid waste dumping site

Seasons	Month-Yr	Site no	Micronutrients (ppm)				Macronutrients (mg/kg)		
			Fe	Mn	Zn	Cu	N	P	K
Pre-monsoon	Jul-11	S1	6.83±0.02	3.75±0.02	9.97±0.02	3.35±0.05	171.67±0.58	8.57±0.21	499.33±1.15
		S2	12.79±0.06	3.74±0.03	13.54±0.04	5.97±0.02	171.67±1.53	9.53±0.15	500±1
		S3	5.57±0.02	3.44±0.04	25.15±0.04	4.82±0.02	172±1	9.63±0.15	499.67±2.52
	Aug-11	S1	5.73±0.02	4.57±0.03	8.17±0.02	2.55±0.04	172.33±1.53	9.13±0.15	500.33±0.58
		S2	10.63±0.02	4.86±0.03	9.36±0.02	4.54±0.02	172.67±0.58	7.57±0.35	502.33±2.08
		S3	4.74±0.02	4.35±0.03	10.16±0.02	8.91±0.02	173±1	7.37±0.06	498.67±1.53
	Sep-11	S1	2.04±0.03	0.94±0.03	13.14±0.02	0.29±0.01	90±1	8.5±0.1	501±1
		S2	6.95±0.02	0.18±0.01	24.68±0.03	0.48±0.02	97.67±0.58	14.4±0.2	461.33±1.53
		S3	3.18±0.01	0.38±0.01	13.14±0.02	0.16±0.02	135.67 ±1.53	11.63±0.15	341.67±1.53
Winter	Oct-11	S1	6.77±0.02	0.26±0.02	21.84±0.02	0.25±0.02	172.33±1.53	11.6±0.2	203±2.0
		S2	4.54±0.03	0.82±0.02	19.45±0.03	0.24±0.02	106.33±1.53	10.13±0.15	361.33±1.53
		S3	5.45±0.03	1.24±0.02	18.35±0.04	0.26±0.02	84.67±1.15	9.13±0.15	508.67±1.53
	Nov-11	S1	2.45±0.02	3.32±0.02	1.19±0.01	1.24±0.01	116.33±1.53	9.3±0.2	419.67±1.53
		S2	2.45±0.03	3.36±0.02	1.16±0.03	1.27±0.02	161±1	7.37±0.15	451.33±1.53
		S3	2.35±0.03	3.37±0.02	1.15±0.03	1.27±0.03	171±1	9.13±0.15	499.67±1.53
	Dec-11	S1	5.44±0.03	1.95±0.02	10.16±0.05	0.25±0.03	116±2	7.37±0.15	286.67±1.53
		S2	5.23±0.02	1.82±0.02	12.33±0.03	0.26±0.02	97.67±0.58	6.83±0.06	498.67±1.53
		S3	6.05±0.02	1.82±0.02	10.28±0.02	0.26±0.01	153±2	7.43±0.15	206.33±1.53
Monsoon	Jan-12	S1	6.13±0.02	1.85±0.02	11.74±0.02	0.38±0.02	96±1	5.77±0.15	498.67±1.53
		S2	5.95±0.02	1.77±0.02	12.53±0.04	0.26±0.02	135±2	6.77±0.15	499±1
		S3	5.72±0.03	1.84±0.04	12.05±0.03	0.32±0.02	142±2.65	7.3±0.1	498.67±1.53
	Feb-12	S1	6.77±0.02	1.94±0.02	12.14±0.02	0.47±0.03	136±1	12.67±0.25	498.33±2.08
		S2	7.07±0.03	1.63±0.03	11.17±0.02	0.53±0.02	127±1	10.2±0.1	498.67±1.53
		S3	7.13±0.02	1.85±0.02	11.83±0.03	0.64±0.03	136±2	13.17±0.21	499±1
	Mar-12	S1	7.84±0.03	1.74±0.02	12.12±0.03	0.69±0.01	132.33±1.53	13.4±0.2	498.67±1.53
		S2	6.94±0.03	1.84±0.02	11.82±0.02	0.56±0.02	122±2.65	11.27±0.12	499±1
		S3	7.12±0.02	1.73±0.03	12.13±0.02	0.84±0.03	130±1	10.5±0.2	450.33±1.53
Post-monsoon	Apr-12	S1	17.37± 0.31	5.79± 0.35	17.56± 0.23	17.73± 0.32	154.2± 1.24	5.77± 0.23	496.61± 0.54
		S2	19.7± 0.61	6.6± 0.26	20.71± 0.29	15.55± 0.37	142.2± 0.33	4.66± 0.16	498.02± 0.1
		S3	14.53± 0.5	8.63± 0.25	11.66± 0.27	6.44± 0.11	141.46± 0.44	4.82± 0.1	496.15± 0.82
	May-12	S1	18.2± 0.3	5.97± 0.21	17.85± 0.08	17.16± 0.71	154.09±1.02	4.67± 0.42	495.2± 1.13
		S2	20.07 ±0.24	6.82 ±0.11	20.48± 0.18	15.78 ±0.35	140.88 ±0.82	4.23± 0.25	495.77± 1.07
		S3	15.69± 0.6	8.84± 0.09	12.17± 0.34	6.39± 0.42	139.12± 0.9	3.9± 0.1	494.57± 4
	Jun-12	S1	17.1±0.3	5.47±0.35	17.37±0.38	17.37±0.35	153.67±5.51	5.5±0.3	496.33±4.04
		S2	20.43±0.21	6.3±0.36	20.27±0.25	15.3±0.44	141.4±0.3	4.53±0.31	497.33±3.79
		S3	14.53±0.38	8.53±0.31	11.27±0.38	6.03±0.15	141.4±0.3	4.5±0.36	496.33±3.51

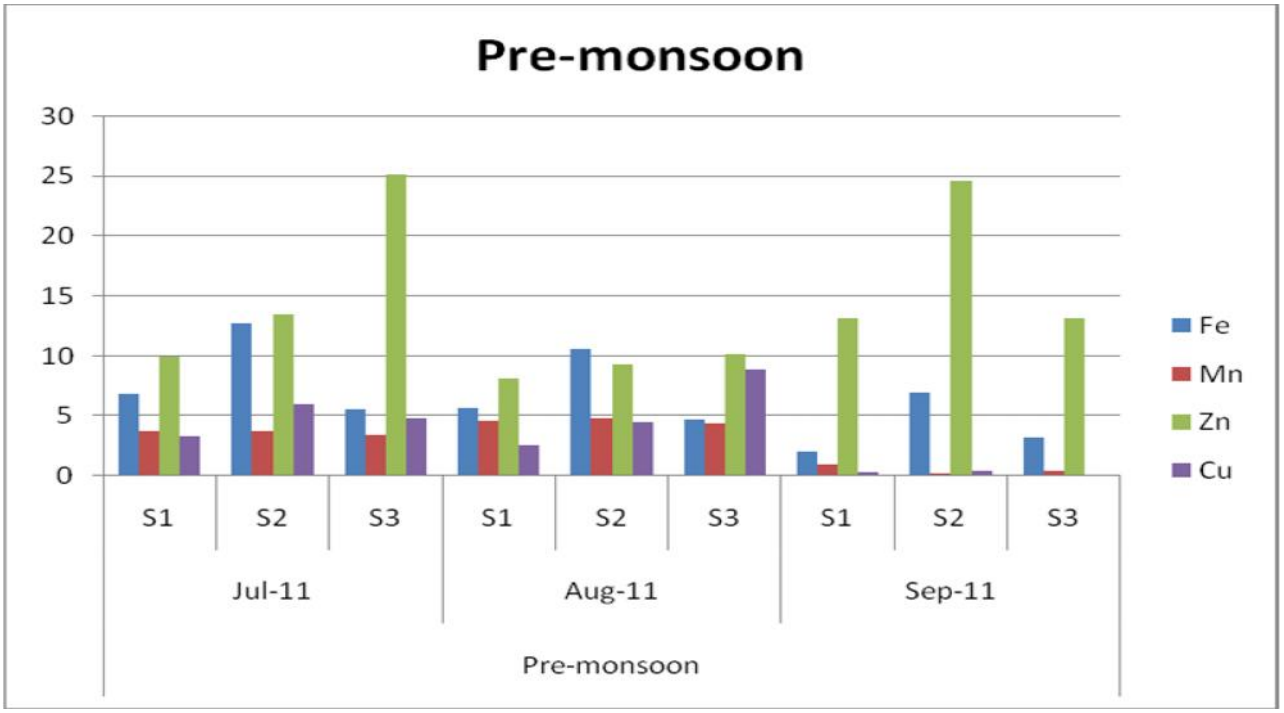

Fig: 5 Analysis of Micronutrient Pre-Monsoon

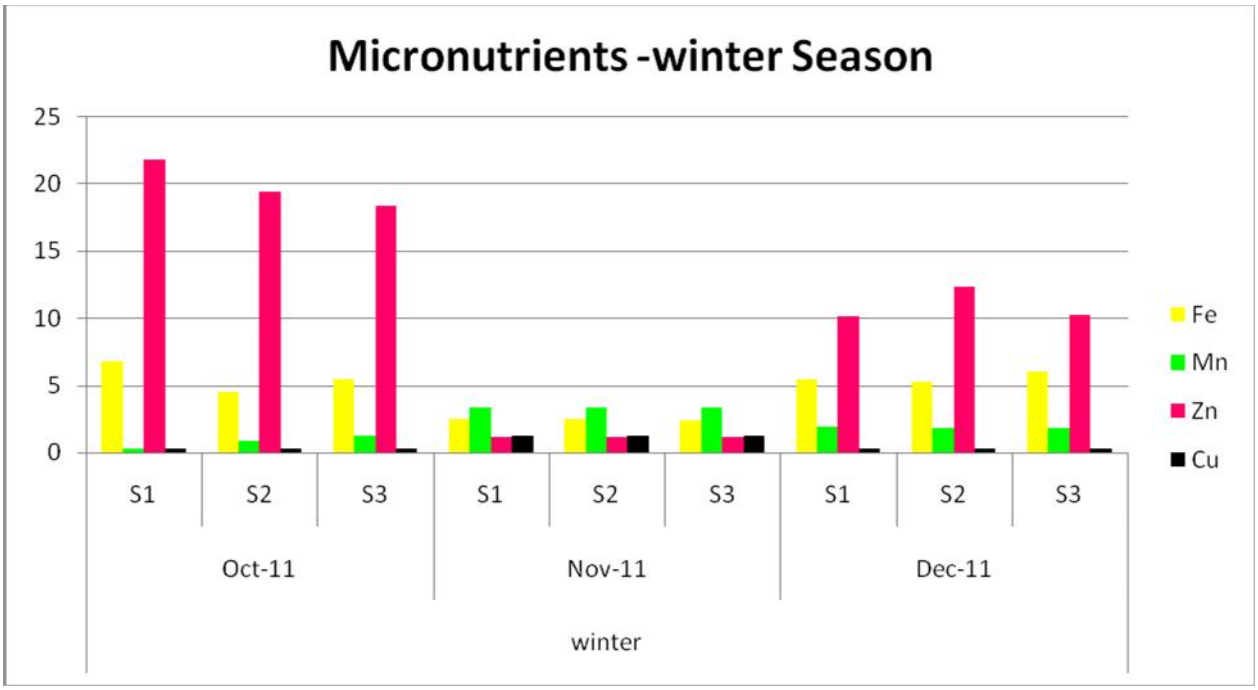

Fig: 6 Analysis of Micronutrient Winter

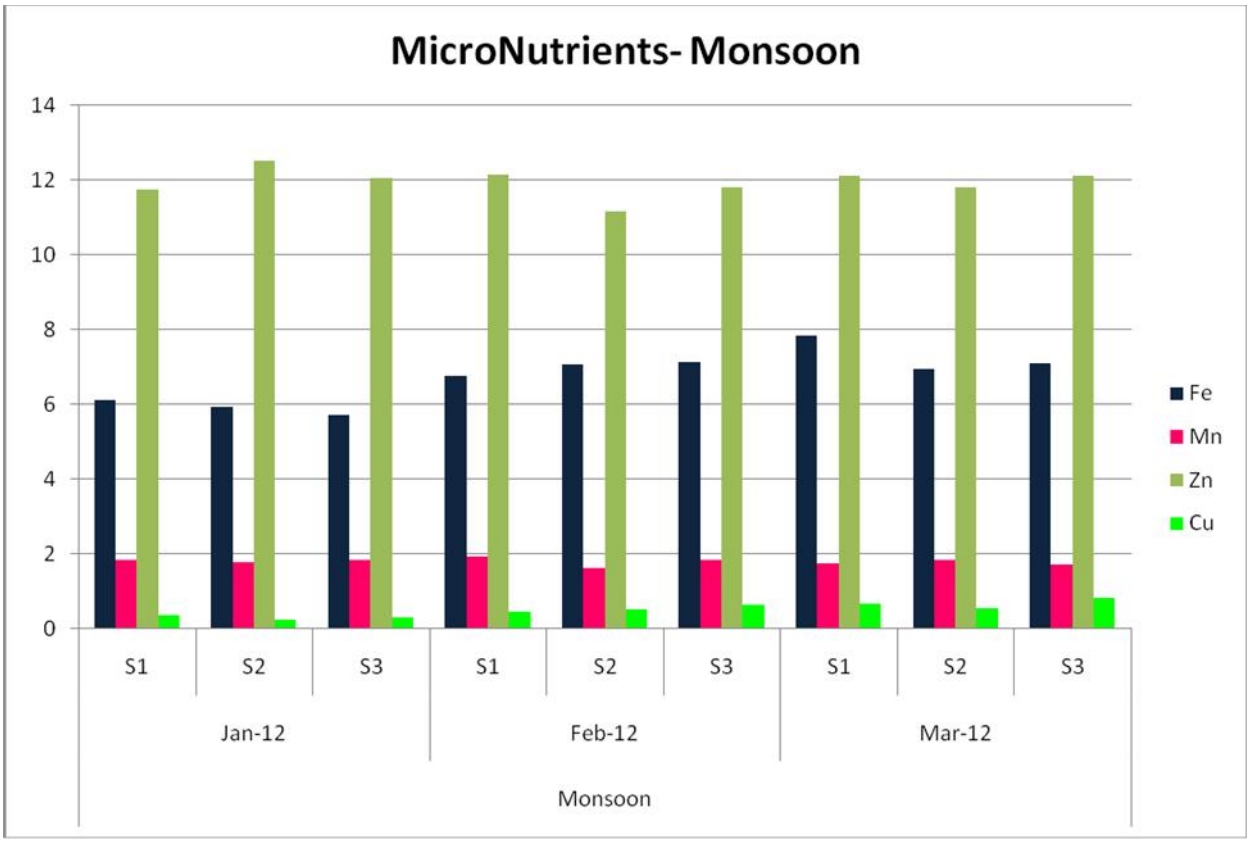

Fig 7: Analysis of Micronutrient Monsoon

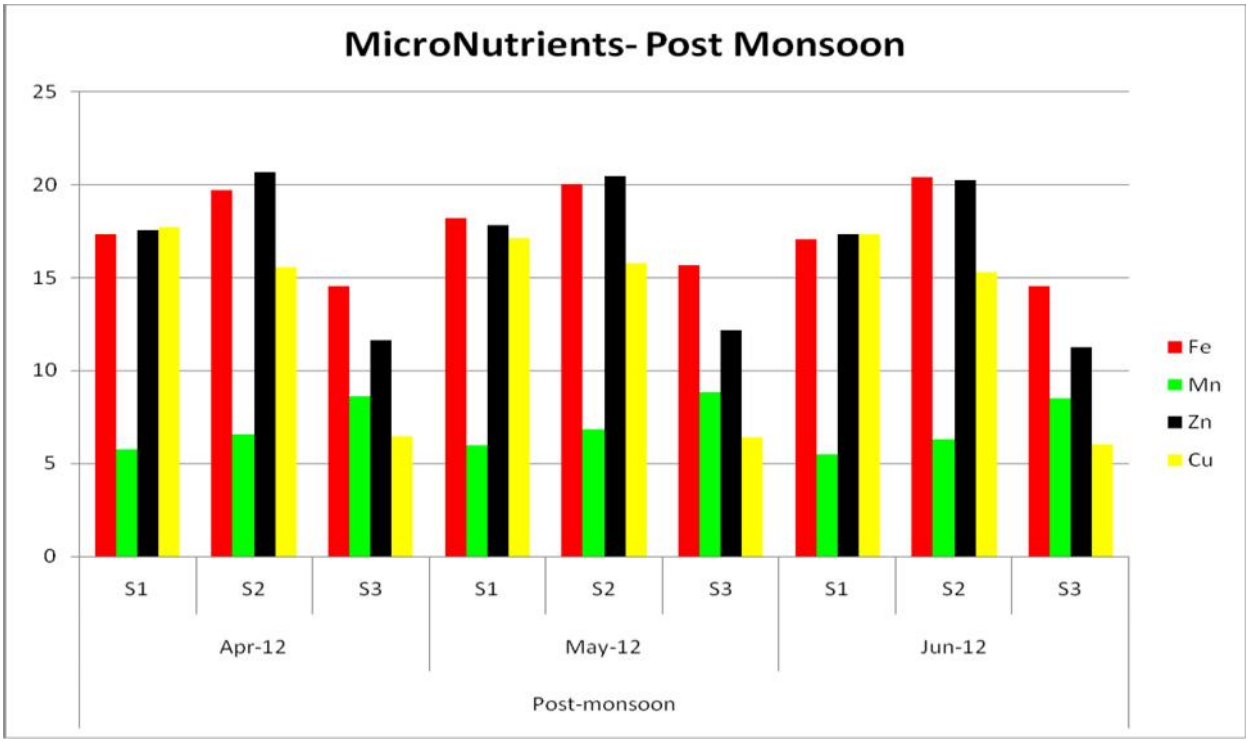

Fig 8: Analysis of Micronutrient Post-Monsoon

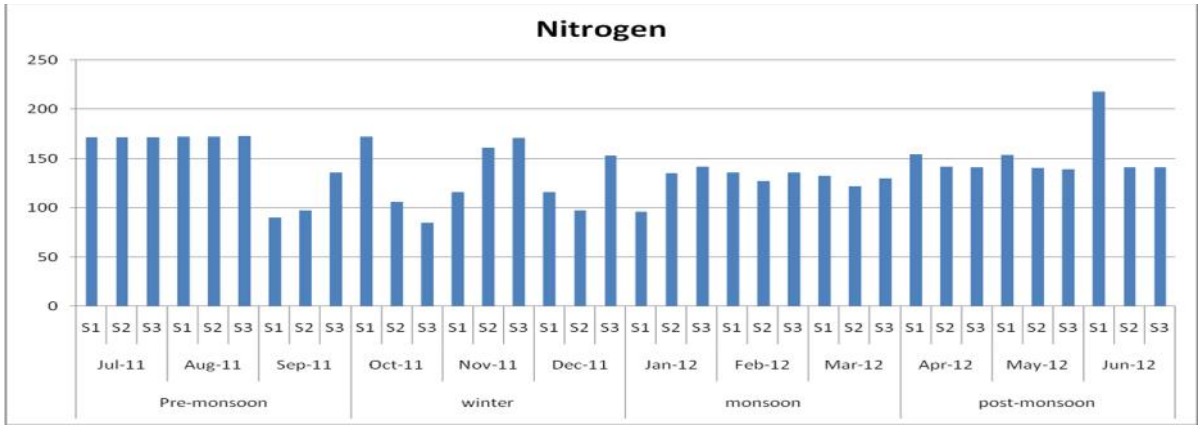

Fig 9: Analysis of Macronutrient Nitrogen

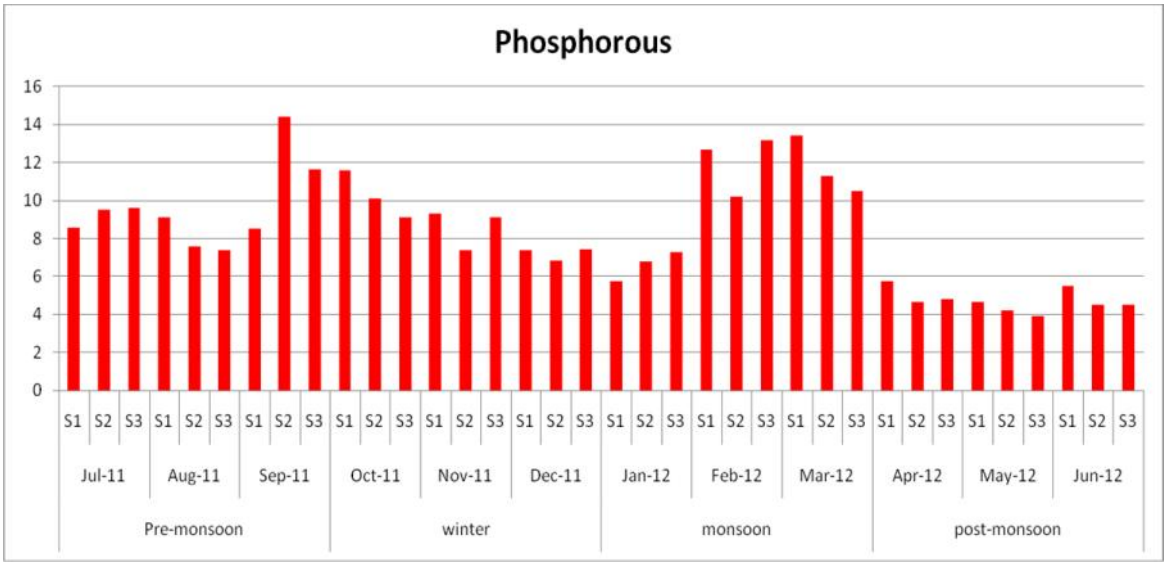

Fig 10: Analysis of Macronutrient Phosphorous

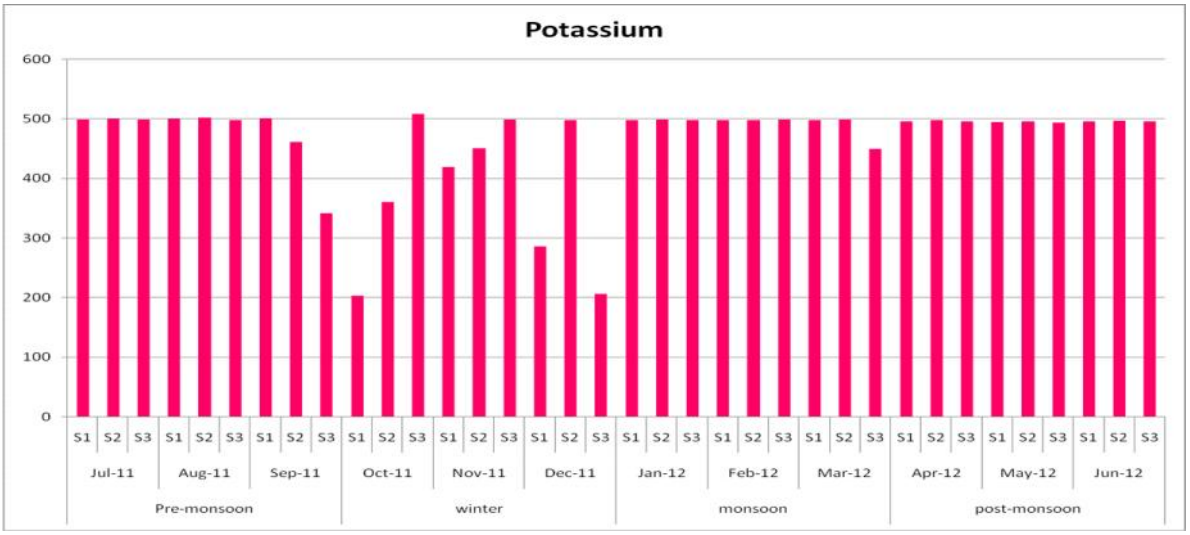

Fig 11: Analysis of Macronutrient Potassium

Conclusion

The use of MSW as compost / vermicompost offers a unique opportunity for economical disposal. The analysis of MSW dumping site soil indicates that it is good source of nutrients for the agriculture sector. On the basis of result MSW compost can be recommended to the farmers to obtain improvement of physico-chemical properties of soil.

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