ISSN: 0973-4929, Vol. 14, No. (1) 2019, Pg. 149-158

Current World Environment

www.cwejournal.org

Comparative Evaluation of Chemical Composition of Commercially Available Windrow Compost Sample and Privately Prepared Invessel Compost samples.

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Abstract

In developing countries like Pakistan the organic waste production is comparatively high. Composting is a good option to overcome problems related to management of organic waste. Compost produced from solid waste should be according to the standards set for soil to ensure beneficial results in plants. The objectives of the study were to determine the quality of compost used in agricultural lands in different areas of country. In the study area the commercially available compost is prepared by windrow composting method. Some home gardeners prepare compost by invessel method. But the sale of commercial compost decreased with the passage of time. One of the reasons behind this includes low quality compost and less desired results in terms of soil fertility. Comparative analysis of windrow compost sample and in-vessel compost samples were carried out to identify the fate of these composts in terms of international standards. Analysis results revealed that some parameters were lower than standard values i.e. moisture content was less than 45 % in all samples, carbon nitrogen (C : N) ratio was less than 25 which should be > 25, available carbon was < 35 % in all samples and burned carbon was also < 35 % in all samples. Compost is used as a soil conditioner and low level fertilizer however if its nutritional value is not according to the standard it may be no longer beneficial for plants. Substandard compost can also cause microbial degradation in soil and can make it anaerobic as well.

Article History

Received: 30 January 2019
Accepted: 10 April 2019

Keywords

Analysis of Compost;
Compost Quality.

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Doi: http://dx.doi.org/10.12944/CWE.14.1.14

Introduction

In agrarian countries like Pakistan the amount of organic waste in solid waste is upto 75 %. Most of organic waste is dumped into dumping site without any segregation.[1] Considering the lower economic status of Pakistan's farming community, high capital investment often leads to lower quantity application. These are the reasons why application of organic soil inputs even over a period of years has not been able to regenerate healthy soil to attain sustainable production. In the present agricultural scenario compost is the best option available to restore and enhance soil potential in order to attain sustainable soil and crop productivity.[2] Composting is the biological degradation of organic material in the presence of oxygen, carbon dioxide and water which results in a humus like end product that serves as a natural, sustainable, safe and economical method of waste management.[3]

In the study area people used to make compost in home gardens by invessel method and use it in their own gardens. This type of composting is done in a controlled environment normally in a drum or bucket or any container. While the organic waste of the city is utilized in two different compost plants in which windrow method of composting is done. In windrow composting the organic waste piles are made in rows. It is an aerobic type of composting, aeration of piles is done by turning piles frequently. The final product of this process is stable and enriched humus containing compost consisting of sufficient amount of nutrients required by soil like nitrogen, phosphorus, potassium, calcium and magnesium.[4] It was observed that the sale of commercially prepared compost has been decreased for last few years. Farmers prefer synthetic fertilizers instead of compost. One of the reasons behind this may be that quality of the composts is not up to the mark. And the farmers did not get desired productivity. This study aims to find out quality of compost available in market.

Windrow composting being aerobic and cost effective is the mostly used method to amend soil conditions. Several beneficial effects of compost on soil are being reported by different authors.[5,6] Composting is a best solution to less land availability, eutrophication and climate change.[7] Composting is also an option to recycle industrial organic by-products to be used as soil conditioner.[8]

Besides the benefit mentioned above the composting can also prevent eutrophication as chemical fertilizers contains excessive nutrient (N,P,K) that drains into water bodies and enhance eutrophication.[9] But in study area the commercial compost is not sold out on large scale and the reason is unawareness of the farmers and as well as less beneficial results after using compost.

For sustainable agriculture the nutrients of plants are very important.[10] Chemical fertilizers may increase the fertility of soil but they cause severe environmental pollution. However composting being a biological process can fulfill these needs.[11] But maturity and stability of compost is an important factor in successful use of it, as immature or unstable compost can induce anaerobic condition in soil.[11] Immature compost also causes phytotoxicity due to presence of acids.[12]

Methodology

Sampling

To find out the difference in composition and quality of composts four composting sites were selected and two commercial composting sites where windrow composting is done and two privately produced compost from house by in-vessel composting method. From commercial sites random samples were taken in packed form and then they were mixed by conning and quartering method. Hence two representative samples from each composting plants were obtained.

And two houses were selected for compost sampling where proper method of in-vessel method was followed. Two samples were taken from these two houses.

Sample Analysis

Samples were analyzed to check the compost quality and the detailed analysis are given below.

pH

5 gm of compost sample was mixed in 10 ml of water in a beaker and pH meter was used to check the pH of sample by dipping the probe into the sample solution.[13]

Moisture Content

5 grams of sample was taken in a pre-weighed crucible and kept it in an oven at 105°C for 24 hours. After drying weighed again and the percentage difference of weight was calculated as dry weight of sample was lesser than wet weight and percent moisture content was calculated.[14]

Carbon, Nitrogen Ratio

Kjeldahl Method was used for the determination of total nitrogen, and loss on ignition method was used for the determination of carbon.[15]

Nutrients

(P, K): Flame photometer was used for the determination of potassium and phosphorus was determined by Olsen's method.[16]

Available and Burned Carbon

LECO carbon nitrogen (CN2000) analyzer was used to determine available and burned carbon in the sample.[17]

Salinity

Salinity is actually amount of water soluble salts in a substance. For compost, salinity was determined by Refractometer normally used for determination of soil salinity.[18]

Sodicity

Sodicity is amount of sodium present in substance usually termed as exchangeable sodium percentage (ESP). Sodicity was determined by making solution of compost and 10gm soil in 10ml of water. pH of the solution reflects the amount of sodium present in it. High pH means high sodium content then sodium was analyzed by flame photometer.[19,20]

Pathogen

Pathogen or microbial detection in compost samples was done by simple cultural method. Microbial culture in compost sample was allowed to grow in media and visual confirmation of growth was done.

Results and Discussion

According to compost and soil quality standards, pH of compost should be in between 6.9 to 8.3. It was found that all samples had pH within the range (Fig. 1). The more the pH exceeds 7.5, there will be more chances of gaseous loss of ammonia.[21]

The moisture content of compost should be 45 – 65 % but the samples had very low moisture contents; as show in the figure 2 below. Windrow sample 1 had a moisture content of 11.37 %, windrow sample 2 had 17.58 %, in-vessel sample 1 had 20.7 % and in-vessel sample 2 had 18.5 % of moisture content.

According to compost quality standards the bulk density should be 0.42 to 0.65gm / cm^3. Bulk densities of all the samples were within the range i.e. windrow sample 1 had 0.45, in - vessel sample 2 had 0.4,and in-vessel sample 2 had 0.42 except one windrow sample 1 which bulk density had slightly

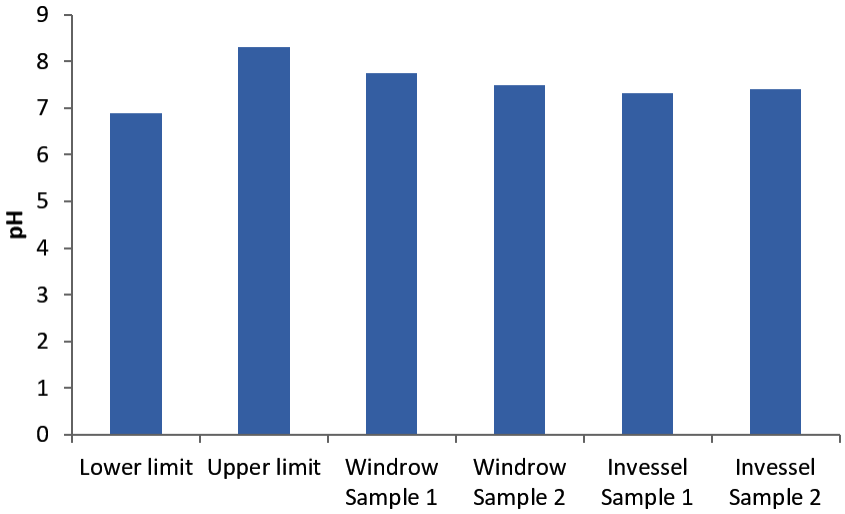

Fig. 1: pH of Compost Samples

higher i.e 0.67 than standard limit (Fig. 3). High bulk density leads to problems in root growth. Roots may remain shallow due to less pore spaces. One study on Maize crop has proved that high bulk density resulted in reduction of root and shoot biomass.[22]

It was found that in privately produced composts the salinity was higher than standard. This compost may increase the salinity of soil resulting in damage to plant. More saline compost can cause salinity in soil. The commercially produced compost in study area had salinity 2.89 and 2.69 DS/m which was within the permissible limit i.e. 4 DS/m. while in home compost sample the salinity was very high i.e. 8.99 and 7.6 DS/m as shown in the fig 4 below. The reason of high salinity in in - vessel sample may be the mishandling of equipment used and improper segregation of organic waste. A study on effect of salinity revealed that high salinity not only affect the root or shoot growth but it can inhibit growth of seed. A high saline soil cannot be cultivated as it can kill seed.[23]

The supply of carbon relative to nitrogen (C: N ratio) determines whether net mineralization or immobilization of nitrogen will occur. Mineralization is conversion of organic nitrogen to mineral forms (like ammonium and nitrate); immobilization is incorporation of nitrogen into microbial biomass. If the C: N ratio is greater than 20:1, microbes will immobilize nitrogen into their biomass.[24] A good compost must have 1 part nitrogen and 25 parts carbon but the samples had very low C:N ratio. All

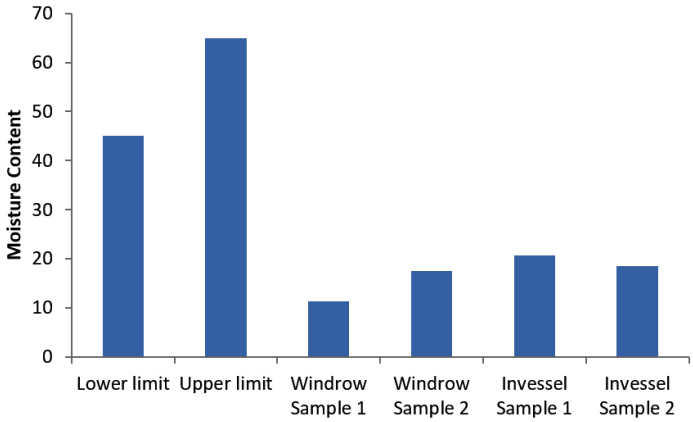

Fig. 2: Moisture Content

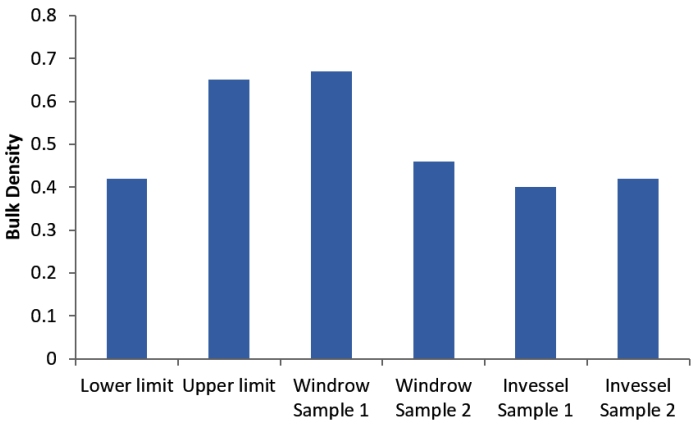

Fig. 3: Bulk density

of the samples in study area had low carbon content than required for a good compost i.e. 17:1 in Windrow saple 1 and 18 : 1 in Windrow sample 2, 12.1:1 in invessel sample 1 while in invessel sample 2, it was 14.1:1 (Fig. 5).

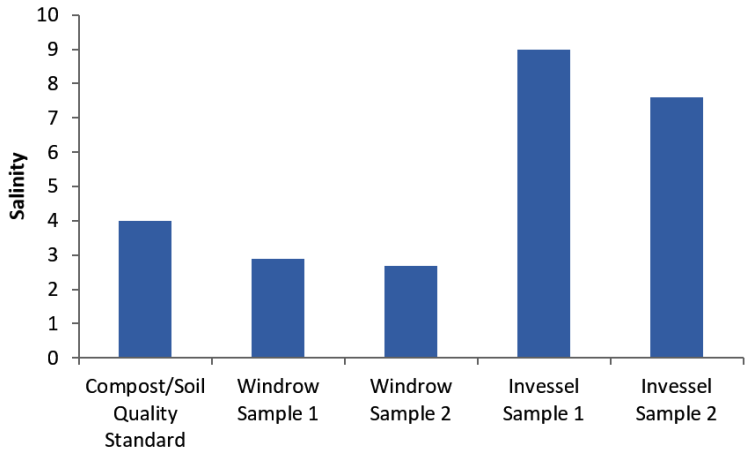

Fig. 4: Salinity in samples

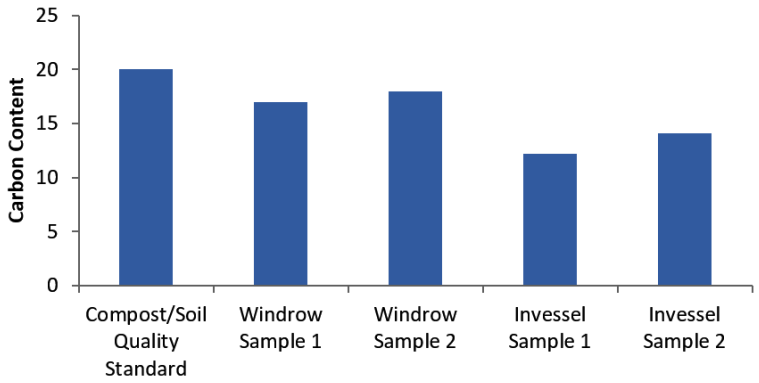

Fig. 5: C:N Ratio

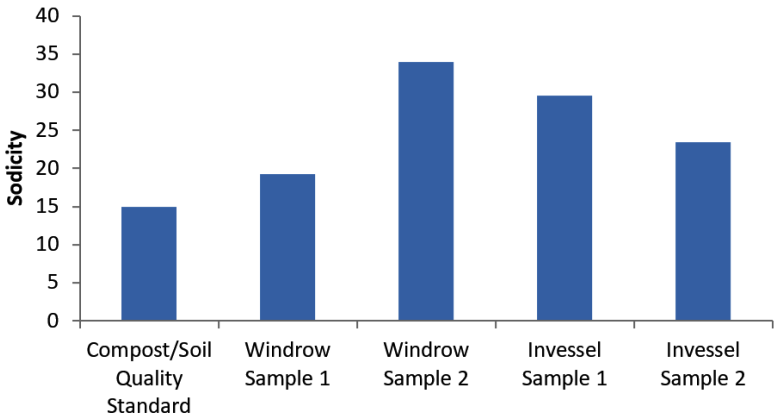

Fig. 6: Sodicity

Sodicity is a term given to the amount of sodium held in a compost. Sodium is one of many types of cations that are bound to clay particles. A Sodic Compost has too much Sodium associated with the negatively charged clay particles. Other cations bound to clay particles include Calcium, Magnesium, Potassium and Hydrogen. Sodicity of sample were found high in all samples as shown in the figure below.

Compost quality standard allows less than 15 mg/Kg of sodium but in all samples the sodium content was high. In windrow sample 1 and 2 the Sodicity was 19.2 and 34 respectively and in invessel samples 1 and the Sodicity was 29.6 and 23.4 mg/Kg (Fig. 6).

Compost has two essential nutrients for its effective use i.e. Nitrogen and Carbon. Normally green waste consists of grass, leaves, vegetables and fruit left overs that are enriched with nitrogen and phosphorous. Brown waste includes hay, paper, wood, dead plants which contain high amount of carbon, hydrogen and oxygen. Green waste contains appreciable amounts of nitrogen, phosphorus, and mineral nutrients and has low C / N ratios.[25]

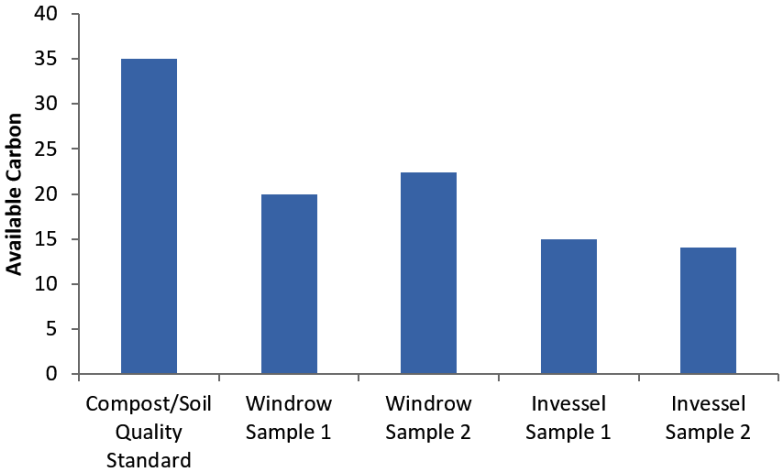

Fig. 7: Available Carbon

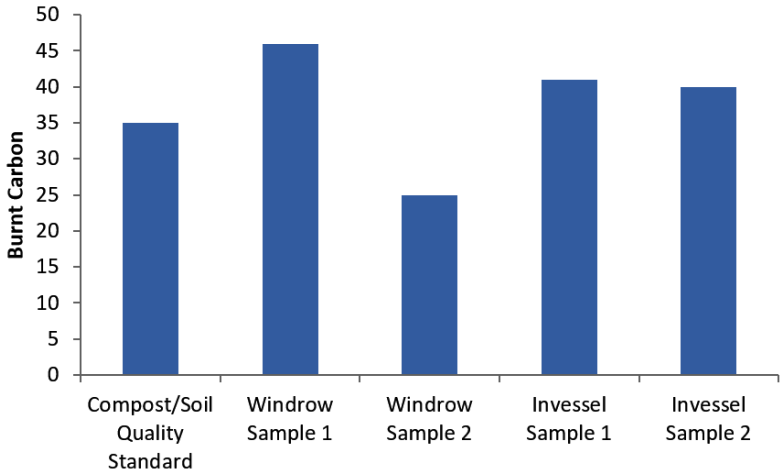

Fig. 8: Burnt Carbon

If there is too much carbon, decomposition slows down as available nitrogen gets used up and the microorganism population drops. So the amount of carbon should be in optimum range otherwise the microbial activity is slowed down.

Both available and burnt carbon should be more than 35 % in compost. But in all the samples of windrow compost there was less available and burnt carbon except in windrow sample 2 the burnt carbon was according to standard limit. In windrow samples 1 and 2, the available carbon was 20 and 22.4 while burnt carbon was 46 and 25 % respectively. While in in-vessel sample 1 and 2 the available carbon was 15 and 14 % respectively and the burnt carbon was according to the standards i.e. 41 and 40 % respectively. Figures 7 and 8 below depict it.

Potassium is not incorporated into organic compounds in plants or animals, so K in compost is readily available. It is an essential nutrient for plants but very low potassium content was found in all compost sample. There should be 620 to 2280 mg/Kg of potassium in compost but the sample had very low content i.e. 0.6, 0.61, 0.6 and 0.6 mg/Kg in windrow 1 and 2 and in-vessel 1 and 2 respectively (Fig. 9).

Phosphorus is also an essential nutrient for plants. If the compost applied does not contain these essential nutrients, it is no more beneficial for the plants. Compost quality standards permits 50 to 120 mg/Kg of phosphorus and in windrow samples 1 and 2 the phosphorus was 75 and 73 mg/Kg respectively

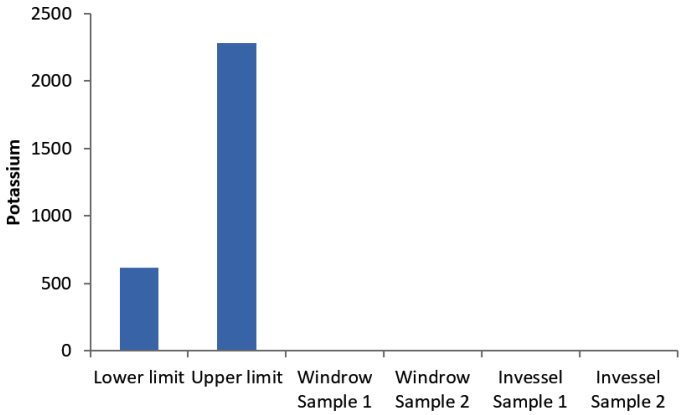

Fig. 9: Potassium

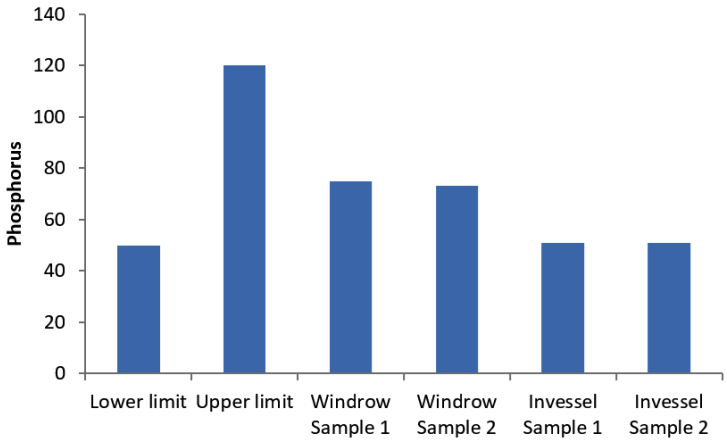

Fig. 10: Phosphorous

while in in-vessel method the compost had 51 mg/Kg of phosphorus in both sample as shown below in figure 10. Deficiency of phosphorus in plants results in stunt growth, inhibition of flowering.[26]

There should be 15 to 240 ppm of nitrogen in compost. The samples had normal nitrogen content, windrow sample 1 had 20 ppm sample 2 had 30 ppm while in both in-vessel samples the nitrogen was 20 ppm (Fig. 11). Low nitrogen content in soil affects the plant bloom and foliage. And too much nitrogen can harm the plant.[27]

It was found that there were or negligible microbes in all the samples of compost (Fig. 12). If pathogen are present on compost then they can infect plants. Compost may contain salmonella, fungus and other pathogenic organisms if it is produced by contaminated waste from municipal source.

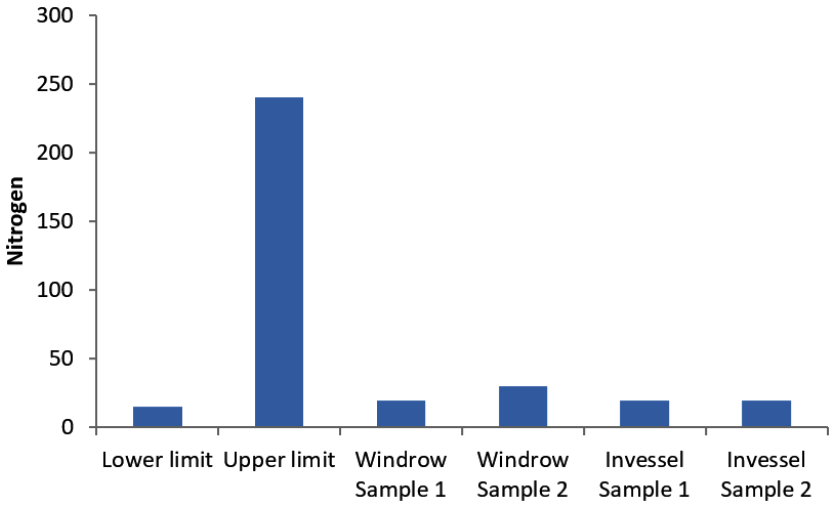

Fig. 11: Nitrogen

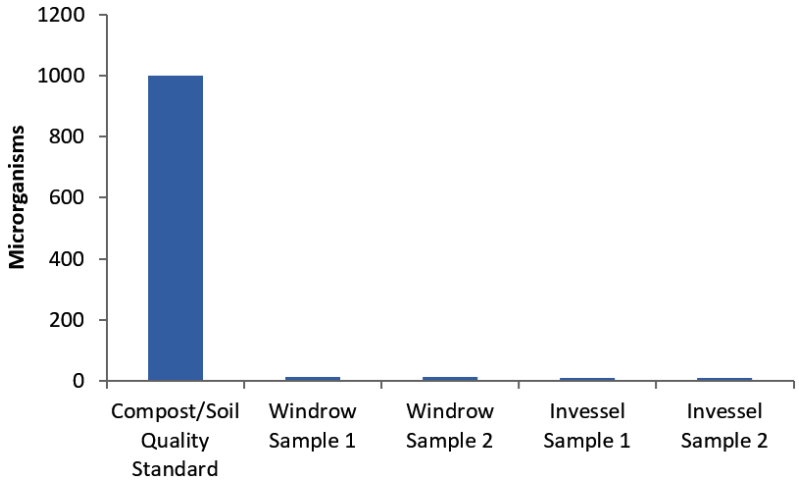

Fig. 12: Microorganisms

Conclusion

From above results obtained by the chemical and physical analysis of the compost, it can be concluded that the compost available in market is not up to the mark. The commercially produced compost does not meet the standards (Compost Quality standards) that is why the farmers who previously bought the compost are no more willing to buy it due to unsatisfactory results. So the hypothesis of the study that compost produced in study area does not give required yield in, crops, can said to be proved correct.

Acknowledgment

I would like to express my sincere thanks and gratitude to Principal College of Earth and Environmental Sciences Prof. Dr Sajid for his providing all the facilities in department to carry out research.

I would express my deepest gratitude to my research supervisor, Prof. Dr. Muhammad Nawaz Chaudhry and Co-Supervisor Dr. Adila Batool for their guidance and encouragement. Without their constant support, I would not have been able to complete my research work.

Conflict of interest

The author(s) declare no conflict of interest.

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