IJO - INTERNATIONAL JOURNAL OF AGRICULTURE AND RESEARCH

(ISSN 2814-189X)

PAPI, D. Y

https://ijojournals.com/ Volume 07 || Issue 11|| November, 2024 ||

UTILIZATION OF DRY SLUDGE POWDER ACQUIRED FROM X-RAY FLUORESCENCE ANALYSIS APPLIED ON MAIZE PLANTS TO REAP ITS BIOMASS

By

[I] PAPI, Y. DANLADI, [II] JOHN I. JOSHUA, [III] LONGTONG G. TURSHAK, and [IV] DANBEN J. MOSES

TETFUND ASSISTED RESEARCH WORK

[I] Department of Plant Science and Biotechnology, Faculty of Natural Sciences, University of Jos, Nigeria.

[II & IV] Department of Science Laboratory Technology, Chemical/Petroleum techniques, Faculty of Natural Sciences, University of Jos, Nigeria.

[III] Department of Science Laboratory Technology, Biological Science Techniques, Faculty of Natural Sciences, University of Jos, Nigeria.

Abstract

This work was carried out to ascertain the performances of dry sludge powder acquired from X-ray florescence analysis as a growth booster for Maize plant (Oba Sudan II) to reap its biomass. Soil pH, Nitrogen and Organic matter were investigated using different procedures such as potentiometrically, Micro-Kyeidahl and Walkley- Black methods respectively in synthetic bags. Soil and Poultry droppings were used as substrates; sludge was collected from water board Jos while the Atomic Absorption Spectroscopy (AAS) was carried out in ATBU Bauchi. The Maize seeds (Oba Sudan II) variety growth showed dry edges of leaves and stunted growth for A3, B3, and produced improve growth for Maize plants propagated using poultry droppings soil booster. The outcomes of AAS showed A3 with the following elements N-12.25%, P-12.48% and K-4.30% while B3 indicated N-11.76, P-0.733% and K-15.48%. The soil depicted a pH of 6.36%, Organic matter of 4.27%, Nitrogen of 0.36% and loamy sand as soil texture. Poultry droppings recorded the following results; pH as 6.92%, Organic matter as 52.01% and Nitrogen as 2.45%. The height of maize plant under poultry droppings indicated significantly higher values than the height of maize plants under A3 and B3. The wet weight of the maize plants under poultry droppings showed significantly higher biomass production values when compared to maize plants under A3 and B3 treatments. The maize plant propagated under poultry droppings is better off, the powder in later field work should be in pellets form and hydroscopic in nature to ease application, health status of the user of the product.

IJO - INTERNATIONAL JOURNAL OF AGRICULTURE AND RESEARCH

(ISSN 2814-189X)

PAPI, D. Y*

https://ijojournals.com/ Volume 07 || Issue 11|| November, 2024 ||

Key Words: Utilization, Dry powder Sludge, X-ray fluorescence, Maize plants, synthetic bags and Biomass

INTRODUCTION

Sludge is a solid or semi-solid by-product of domestic water from homes and storm waste waters treated through aerobic or anaerobic digestion process in wastewater treatment plants (WWTPs) (Isgenic and Kinay, 2005). Sludge may contain some inputs such as metals and metalloids and can occasionally cause reductions in some microbial biomass. In general, the uptake of metals and organic contaminants by plants do not appear to cause a significant hazard to the plants and the concentrations do not surpass the maximum value allowed in the soil (Jaliya *et al*., 2008).

The application of sludge on a crop-land might be a suitable management practice, however, further investigations are needed to investigate the accumulation and persistence of passive hazardous emerging chemicals, pathogens in the environment and formation of harmful intermediate reactions of inorganic and organic products (Larney *et al.,* 2002; El-Ramady *et al*., 2014).

The global population has increased rapidly from 5.3 billion in 1992 to 7.6 billion in 2018 and will reach 9.0 billion in 2050s there is the urgent need to produce more food to take care of the population explosion that will inundate the world in the near future (Agbato, 2003). Such a rapid population growth will cause an increase in the consumption of food and water globally and consequently increase wastewater production along with digested sewage sludge, which represents about 0.3 – 0.5% treated wastewater (Mbah and Onweremadu, 2009).

IJO - INTERNATIONAL JOURNAL OF AGRICULTURE AND RESEARCH

(ISSN 2814-189X) PAPI, D. Y.

https://ijojournals.com/ Volume 07 || Issue 11|| November, 2024 ||

The disposal of digested sludge in a safe way is a major environmental concern all over the world. The application of sludge on land after appropriate processing would support increased sustainability of agricultural productivity as it recycles the nutrients back to the soil and make them available to plants (Madyawa *et al*., 2002; Singh and Agrawal, 2007).

The use of sludge as fertilizer can reduce the need for synthetic inorganic fertilizer by farmers in our communities (Singh and Agrawal, 2009) and can produce some micronutrients that are otherwise not added to the soil but this beneficial plant nutrients from sludge may contain inorganic and organic substances such as, pharmaceuticals and pathogens depending on the inputs of effluents in the wastewater plants and type of digestion used in the process (Sarma *et al*., 2013).

Sludge contains nutrients of heavy mental and metalloids. Some of which are essential macronutrients such as Nitrogen (N), Phosphorous (P), Potassium (K), Calcium Ca) and Manganese (Mn) and some are essential trace elements such as Boron (B), Copper (Cu), Iron (Fe), Nickel (Ni), and Zine (Zn) (Fytili and Zabaniotol, 2008; Marguí *et al*., 2015).

The benefits of adding any sludge as fertilizer to cropland must be compared with the risk of any contamination of the food chain by harmful substances that the sludge may contain and any leaching of the contaminants or plant nutrients to the environment (Basbag and Saruhan, 2004). The awareness regarding inorganic and organic pollutants in food chain is increasing with time though knowledge gap still exit.

IJO - INTERNATIONAL JOURNAL OF AGRICULTURE AND RESEARCH

(ISSN 2814-189X)

This paper tends to develop an alternative to the use of digested sludge to the use of treating the sludge via x-ray fluorescence to remove the heavy metals and metalloids before it is administered on the cropland for crop utilization to produce healthy biomass as fodders for animals and food for man in the midst of the fast increasing of human population on earth.

LITERATUER REVIEW

The sewage sludge (SS) drying in paddle dryers are very scarce and the state of the art equipments in the research does not allow predicting process performances. In short, predicting the drying of sludge at the outlet of a paddle dryer would require calculating both the drying rate and the residence time distribution (RTD) of the sludge in a given operating conditions. However, RTD measurements remain a technical bottleneck for sludge processing and could bring valuable information for the understanding sludge behavior in dryers (Usman *et al*., 2012).

Drying is a necessary step before sewage energetic valorization. Paddle dryers allow working with such a complex material to successful carried out the work. The sludge residence time distribution (RTD) measurement in a continuous paddle dryer is based on detection of mineral tracers by x-ray fluorescence. This offers a linear response to tracer concentration in dry sludge, the protocol leads to a good repeatability of RTD measurement. The application of this technique on sludge with different storage duration at 4^0C emphasizes the influence of this parameter on sludge RTD, thus gives a better paddle dryer performance (Killham and Prosser, 2015).

RTD concept was first introduced as a tool allowing characterization of fluid flows in reactors in a process. It depends on the measurement of a tracer concentration at the outlet of a reactor. The injection of this tracer is not to disturb the flow, a lot of tracing techniques have been developed, they can be basically divided in two categories depending on whether they rely on online or offline analyses (Amir *et al*., 2010).

The RTD concept can be employed for the characterization of any conservative flow of solid part of sludge in a dryer. However, for solid flows, online tracing techniques such as magnetic field or radioactivity detection are complicated to set up. Optical techniques have also been tested but most of the time they are operated offline (color analysis, fluorescence, and absorbance for example) since they might require pre-treatment of the samples (Malathi and Stalin, 2018).

X-ray fluorescence allows detecting any mineral tracer and only requires drying and grinding of the samples. This methodology is applied to illustrate the influence of storage duration on SS flow during drying (Bull *et al*., 2017). The dryer is composed of a 1 m long U-shaped jacketed trough housing a single rotating shaft equipped with 17 regularly spaced wedge-shaped paddles. Two additional blades, tilted at 45°, are placed at each end of the shaft to feed and extract the product more easily (Ling *et al*., 2017).

MATERIALS AND METHODS

STUDY AREA

A fenced compound in Jos North Lay Out Lamingo Road Katon-Rikkos of Jos North was used for the experiment. The compound is safe against herbivores and has a bore hole for stable water

IJO - INTERNATIONAL JOURNAL OF AGRICULTURE AND RESEARCH

(ISSN 2814-189X) PAPI, D. Y*

https://ijojournals.com/ Volume 07 || Issue 11|| November, 2024 ||

supply. The compound is located at Plot 83 of Jos North Lay Out and has the coordinates of 9^o 53`32`` N and 8$^o$54`25`` E. The community is a residential area occupied by civil servants working in and out of the state.

EXPERIMENTAL DESIGN

It was a synthetic bag research, thus the design was a randomized complete block design (RCBD) with four replicates. Data were collected and analyzed by two-way analysis of variance (ANOVA) at $p \leq 0.05$ using statistical functions of Co-Stat Software for statistics (2004). Further, a least significant difference (LSD $_{0.05}$) test was used to differentiate between significant and non-significant means. The maize plants were sowed in two rows per each of the three treatments of A3, B3 and Poultry droppings (PD). The maize plants were sowed 30 cm apart to avoid over-crowding.

PREPARATION OF SOIL, PLANTING AND APPLICATION OF INPUTS

The soil sample was collected using soil auger and stored in 12 pieces of synthetic bags, each treatment having 4 bags. On the 26th July 2023, the maize seeds of Oba Sudan II variety were sowed observing specific spacing of 30 cm apart. The substances namely A3, B3 and PD were applied at 0. 25 kg on each plant twice because the plants were not growing well at the period of the experiment, on the 11th August, 2023 and on the 20th September, 2023.

DATA COLLECTION

IJO - INTERNATIONAL JOURNAL OF AGRICULTURE AND RESEARCH

(ISSN 2814-189X) PAPI, D. Y.

https://ijojournals.com/ Volume 07 || Issue 11|| November, 2024 ||

The research team visited water Board on the 30th November, 2021 for collection of sludge samples from the three treatment sites of Nabor-Gwom, Laminga and Shen treatment plants. The sludge samples collected were sent to the Laboratory for analysis.

METHODS OF DATA ANALYSIS

FIELD SAMPLES COLLECTED

The data collected were geared toward achieving the objectives of the research such as, Plant height, colour of the leaves and wet weight (biomass) of the entire plant including the cobs and stems.

TEST OF SOIL AND POULTRY DROPPINGS

Soil samples were collected using soil auger and hand trowel to commence the analysis. In the laboratory, large lumps were further crushed and the soil was finally spread out on a large sheet of paper on benches and allowed to air dry. When air dried, the soil sample was ground in a mortar with a woody pestle which allows the aggregate particles to be crushed but no actual broken down occurred. The sufficiently ground soil was sieved through a 2mm sieve, while stones and large root residues were discarded. The fine soil which passed through a 2 mm sieve was stored in labeled small polythene bags ready for laboratory analysis (Van-Reeuwijk, 2002)

The following procedures were used in the analysis of each soil parameter.

The pH was determined using the potentiometricaly method with the supernatant suspension of a 1, 25 soil liquid mixture of pH.H_2O (Van-Reeuwijk, 2002).

Nitrogen was investigated using Micro-Kjeidahl procedure. The sample was digested in Sulpheric acid and Hydrogen Perioxide with Selenium as a catalyst and where organic nitrogen was converted to ammonium sulphate. The solution was made alkaline and ammonia was then distilled. The evolved ammonia was trapped in boric acid and titrated with standard acid. The procedure determines all soil nitrogen except that in nitrate (Van-Reeuwijk, 2002).

Organic matter was examined using the Walkley –black procedure. There was the wet combustion of organic matter with a mixture of Potassium dichromate and Sulphuric acid at about 125^0C. The residual dichromate is titrated against ferrous Sulphate. To compensate for the uncompleted destruction, an empirical correction factor of 1.3 was applied (Van-Reeuwijk, 2002).

The quantity of litter or poultry droppings can vary greatly from farm to farm depending on the amount of feed, age of the chickens the feed type and number of flock that are grown on a litter. The total quantity was handled by (NRAES,1999 method which was used as in Patterson *et al*., 1998).

X-RAY FLUORESCENCE (XRF) ANALYSIS

The atomic absorption spectroscopy (AAS) was carried out at Abubakar Tafewa Belewa University, Bauchi to determine the concentration of important elements in the sludge (Nitrogen, Phosphorus and Potassium) in formulated Organo-fertilizer OF-As and OF-Bs samples. Sewage sludge (SS) is the main by-product from wastewater treatment plants (WWTP), included the mixture of globally nitrogen and sulfur-containing organic material, microorganisms and minerals (mainly P, K, Fe, Ca, but also trace elements). SS is treated according to several pathways for stabilization of the biological activities (anaerobic or prolonged aerobic digestion for example), and/or dewatering (centrifuges, belt filters) (Fytili and Zabaniotou, 2008),

RESULTS

The results of the work will guide in the producing of cheap organic fertilizer for plant growth through the use of sludge as waste material from our homes in urban areas.

Plates 1-3 show the growth and colour of the maize plants used in the research work.

Plate 1(A3)

Plate 2 (B3)

Plate 3 (PD)

Plate 1- A3 shows maize plants of A3 substance, the powder samples were applied to boost the soil nutrients. The plants showed bown dry edges leaves and stunted growth as a result of nutrient deficiency.

IJO - INTERNATIONAL JOURNAL OF AGRICULTURE AND RESEARCH

(ISSN 2814-189X) PAPI, D. Y*

https://ijojournals.com/ Volume 07 || Issue 11|| November, 2024 ||

Plate 2-B3 shows maize plants that B3 substance, the power samples ware applied to improve the nutrients of the soil, the plants showed better growth to the previous plate 1 with elongated stems and green leaves.

Plate 3-PD shows maize plants and poutry droppings were applied to add organic nutrients for better growth. The plants growth were better in height and green colour, although the stem of the experimental plants were leaky but green and healthy.

ATOMIC ABSORPTION SPECTROSCOPY (AAS) ANALYSIS OF THE FORMULATED ORGANO-FERTILIZERS

Table 1. Analysis showing the concentration of the important elements (Nitrogen, Phosphorus and Potassium) in formulated Organo-fertilizer OF-As and OF-Bs samples.

S/N	Samples	Nitrogen (%)	Phosphorus (Mg/Kg)	Potassium (Mg/Kg)
1	OF-A1	7.28	8.06	5.119
2	OF-A2	10.29	4.34	1.585
***3**	**OF-A3**	**12.25**	**12.48**	**4.304**
4	OF-A4	11.13	4.92	3.142
5	OF-A5	6.09	16.86	2.87
6	OF-B1	17.08	0.821	2.04
7	OF-B2	12.95	0.638	6.84
****8**	**OF-B3**	**11.76**	**0.733**	**15.42**
9	OF-B4	14.98	1.141	8.72
10	OF-B5	9.73	1.371	6.31

IJO - INTERNATIONAL JOURNAL OF AGRICULTURE AND RESEARCH

(ISSN 2814-189X)

PAPI, D. Y*

https://ijojournals.com/ Volume 07 || Issue 11|| November, 2024 ||

Table 1 depicts a sample *3 (OF-A3) were applied to maize plants seen in plate 1. This sample is deficiency in Potassium Mg/Kg (4.304) which resulted in stunted growth and brown- reddish colour of the maize plants. While **8 (OF-B3) as another sample applied on Plate 2 maize plants for results. The plants also showed that the amount of Phosphorous Mg/Kg (0.733) was low. For both samples used the percentages of Nitrogen contents were high.

RESULTS OF SOIL ANALYSIS

Table 2. shows the results of soil analysis carried out to show the parameters

SAMPLE	PH	% Organic matter	% Nitrogen	Texture
SOIL	6.36 (H_2O)	4.27	0.36	Loamy sand
POULTRY DROPPINGS	6.92 (H_2O)	52.01	2.45	-

Table 2 shows the results of analyses of soil and poultry droppings, indicating percentages for Organic matter and Nitrogen, both were lower for soil sample when compared to that of poultry droppings applied for the treatments. The texture of the soil showed loamy sand.

Table 3 Results from analysis of data collected on the field

Treatment	Height-31	Height-29	Wet Weight
A3	19.00±1.83b	27.00±4.76b	0.16±0.02b
B3	26.75±2.50a	39.50±4.20b	0.54±0.02b
PD	30.5±7.42a	64.75±19.75a	1.72±0.05a

IJO - INTERNATIONAL JOURNAL OF AGRICULTURE AND RESEARCH

(ISSN 2814-189X) PAPI, D. Y·

https://ijojournals.com/ Volume 07 || Issue 11|| November, 2024 ||

LSD ($_{0.05}$)	7.68	20.53	0.04

Table 3 reveals that the means having the same letter (s) across the same column are significantly different at 5% level of probability. The height of plants under A3 are significantly lowered when compared with that under B3 and PD and the wet weight of maize plants under Poultry droppings (PD) were significantly higher when compared to others treatments.

DISCUSSION

Soil analysis showed lower percentage contents for organic matter and Nitrogen and thus the reason for the retarded growth observed in the first two treatments while specimens propagate on poultry droppings showed green leaves used for photosynthesis and better growth outlook than other treatments. The texture of the soil used was loamy sand which is still not ideal for the growing of agricultural crops due to its high porosity, thus high percolation of water and nutrients meant to be absorbed by the maize plants.

The atomic absorption spectroscopy was carried out to ascertain the concentration of important elements like nitrogen, phosphorus and potassium in the formulated organo-fertilizer or powder substances. Several samples were obtained from the atomic absorption spectroscopy but OF-A3 and OF-B3 were selected randomly to be used for investigation since these two samples made better percentages for phosphorous, Nitrogen and potassium although some of the samples

(ISSN 2814-189X) PAPI, D. Y*
https://ijojournals.com/ Volume 07 || Issue 11|| November, 2024 ||

results are still at the lower percentages depending on the interactions of the metals in the sludge collected at water board.

The maize plants grown for the research work showed some deficiencies in Phosphorus, potassium and Nitrogen. Nitrogen is essential for chlorophyll production and lack of it in the soil and organic fertilizer prepared can lead to reduction in chlorophyll content, causing the leaves to turn brown or yellow with stunted growth and scaly leaves, Phosphorus deficiency may cause stunted growth, dark green coloration of the leaves, necrotic sports on the leaves, a purple colour to the leaves and leaf cupping. These assertions are similar to the findings of other researchers like Kuldeep *et al*, 2023.

Some of maize plants showed remarkable different in heights probably due to the differences in the percentages of Nitrogen, phosphorus and potassium in the soil and poultry droppings. The height of the maize plants in the treatments A3 and B3 showed retarded growth while the treatment that utilized poultry droppings revealed better growth of the maize plants because of high availability of organic matter percentage in poultry droppings.

Wet weight was taken to ascertain the biomass (mass) built up during growth and ideal photosynthetic activities due to good soil and other attributes. The biomass showed significant difference between those samples treated with poultry droppings and A3, B3 due to deficiencies in the nutrients in the sludge and soil samples. The soil sample used for this investigation showed lower percentage contents for Nitrogen and Organic Matter when compared with that of poultry droppings, hence better growth or weight which translated to fodder for animals and food for man were noted

The biomass or plant weight collected at the end of the research did not give a better performance due to deficiencies of nutrients in the substrates used for the experimentation and that has impacted negatively on the overall weight or biomass of the plants except for maize plant grown under poultry droppings.

CONCLUSION

It can be concluded that all nutrient elements namely (N, P, K, S, Ca, Mg, Fe, Zn) can influence crop quality as extrapolated by this study. The samples of the organo-fertilizers used did not give good results as envisaged because both the prepared fertilizer sample and soil samples used were deficient in nitrogen, potassium and phosphorus, the performance of the maize plant variety was unfit as seen in the wet weight of the plants. A better investigation can be carried out by improving on the elements via other additives for better growth.

RECOMMENDATIONS

The Organo- fertilizer should be converted from it powder state to pellets for the health and easy application of the substance by the users on the field. Each times the powders were used, the user comes down with ill- health resulting from the microbes inhaled during the process of application. A better humus soil could be used in subsequent field work with improved organo-fertilizer, so that the organo-fertilizer serves as a booster of nutrients for vegetative and reproductive growths. The deficiencies in the percentages of phosphorus and potassium can be improved upon for better growth, thus for better biomass.

REFERENCES

Agbato, S.O. (2003). Principles and practices of crop production Odumatt Press Publisher, Oyo, pp. 57-62.

Amir, S.; Jouraiphy, A.; Meddich, A.; El Gharous, M.; Winterton, P.; Hafidi, M. (2010). Structural study of humic acids during composting of activated sludge-green waste: Elemental analysis, FTIR and 13C NMR. *Journal of Hazardous Materials*, *177*, 524–529.

Basbag, M, Gul I, Saruhan V., (2004). Performance of lucerne cultivars under irrigated conditions in the Southeastern Anatolia Region of Turkey. New Zealand. *Journal of Agricultural Reserves,* 47, 225-232.

Bull, A., Brown, M.T., & Turner, A. (2017). Novel use of field-portable-XRF for the direct analysis of trace elements in marine macro-algae. *Environmental Pollution*, *220*, 228–233.

El-Ramady, H.R.; Alshaal, T.A.; Amer, M.M.; Domokos-Szabolcsy, É.; Elhawat, N.; Prokisch, J.; Fari, M. (2014). Soil Quality and Plant Nutrition. *Sustainable Agricultural Reviews*, *14*, 345–447.

Fytili, D.; Zabaniotou, A. (2008). Utilization of sewage sludge in EU application of old and new methods—A review. *Renewable Sustainable Energy Reviews*, *12*, 116–140.

Jaliya, M.M, Falaki A.M, Mahmud , M. Sani, Y.A (2008). Effect of sowing date and NPK fertilizer rate on yield and yield components of quality protein maize (Zea mays L.). *Journal of Agricultural & Biological Science* 3(2) 28-33

Isgenc, M.F, Kinay, E.H (2005). Sludge in Turkey. I. National sludge symposium, pp. 519-528.

Larney, F.J.; Angers, D. A. (2012). The role of organic amendments in soil reclamation: A review. *Canadian Journal of Soil Science*, *92*, 19–38.

Ling, Y.-Y., Zhang, J.-J., Liu, K., Ge, M.-H., Wang, M., & Wang, J.-M. (2017). Geochemistry, geochronology, and tectonic setting of Early Cretaceous volcanic rocks in the northern segment of the Tan-Lu Fault region, northeast China. *Journal of Asian Earth Sciences*, *144*, 303–322.

Killham, K.; Prosser, J.I (2015) The Bacteria and Archaea. In *Soil Microbiology, Ecology and Biochemistry*, 4th ed.; Academic Press: San Diego, CA, USA, Pp. 41–76.

Kuldeep, K., Vikas, K., Vitendra, K.M. (2023), Essential Nutrients for Plant growth, Nutrients function deficiency symptoms. A review-*Dizhen Dizhi Journa*l 15 (12) 39-45.

Madyiwa, S, Chimbari, M, Nyamangara, J, Bangira, C. (2002). Cumulative Effects of Sewage Sludge and Effluent Mixture Application on Soil Properties of Sandy Soil Under a Mixture of Star and Kikuyu Grasses In Zimbabwe, *Journal of Physical and Chemical Earth*, 27, 747-753.

Malathi, P.; Stalin, P. (2018). Evaluation of AB—DTPA Extractant for Multinutrients Extraction in Soils. *International Journal of Current Microbiological in Applied Science*, *7*, 1192–1205.

Marguí, E.; Iglesias, M.; Camps, F.; Sala, L.; Hidalgo, M. (2015). Long-term use of biosolids as organic fertilizers in agricultural soils: Potentially toxic elements occurrence and mobility. *Environmental Science and Pollution Reserves* , *23*, 4454–4464.

Mbah, C. N. and Onweremadu, E. U. (2009). Effect of organic and mineral fertilizer inputs on soil and maize grain yield in an Acid Ultisol in Abakaliki-South Eastern Nigeria. American- *Eurasian Journal of Agronomy*. 2(1)7-12.

NRAES, (1999). Poultry Waste Management Handbook (NRAES-132). Natural Resource, Agriculture, and Engineering Service, Cooperative Extension, 152 Riley-Robb Hall, Ithaca, NY 14853-5701.

Patterson, P.H., E.S. Lorenz, and W.D. Weaver, Jr. (1998). Litter Production and Nutrients from Commercial Broiler Chickens. *Journal of Applied Poultry Research*, 7247-252.

Sarma, B, Goge N, Paul, S, Baroowa, B (2013). Impact of inorganic N fertilizer on soil organic carbon and physico- chemical properties of alluvial soil of Assam. *International Journal of Agriculture, Food, Science and Technology*, 4 (8) 743-744.

Singh, R.; Agrawal, M. (2007) Effects of sewage sludge amendment on heavy metal accumulation and consequent responses of *Beta vulgaris* plants. *Chemosphere* , *67*, 2229– 2240.

Singh, R.P.; Agrawal, M. (2009). Use of sewage sludge as fertilizer supplement for *Abelmoschus esculentus* plants: Physiological, biochemical and growth responses. *International Journal of Environmental Waste Management 3*, 91–106.

Usman, K.; Khan, S.; Ghulam, S.; Khan, M.A.; Khan, N.; Khalil, S.K.(2012). Sewage Sludge: An Important Biological Resource for Sustainable Agriculture and Its Environmental Implications. *American journal of Plant Science, 3*, 1708–1721.

Van Reeuwijk, L.P. (2002). Procedures for Soil Analysis. 6th Edition, International Soil Reference and Information Centre, Wageningen. *Journal of Environmental Protection*, 13 (2), 1-2