EFFECT OF INDUSTRAIL WASTE ON SOIL

(A CASE STUDY OF OKUN STREAM, IN ILORIN KWARA STATE)

BY

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BEING A FINAL YEAR PROJECT REPORT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF BARCHELOR OF ENGINEERING (B.ENG) DEGREE IN AGRICULTURAL & BIORESOURCES ENGINEERING, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGER STATE.

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Declaration

I hereby declare that this project work is a record of a research work that was undertaken and written by me. It has not been presented before for any degree or diploma or certificate at any university or institution. Information derived from personal communications, published and unpublished work were duly referenced in the text.

....   25/01/2011

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CERTIFICATION

This is to certify that the project entitled "Effect of Industrial Waste on Soil, a Case Study Of Okun Stream, in Ilorin Kwara State" by Abulkadir, Sheikh Jibril meets the regulations governing the award of the degree of Bachelor of Engineering (B. ENG.) of the Federal University of Technology, Minna, and it is approved for its contribution to scientific knowledge and literary presentation.

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Dedication

This project is dedicated to Almighty Allah (S.W.T) for His infinite bounties and that has made it possible for me to complete my programme successfully.

And also to my caring parents, brothers and sisters, for all the love, support and care.

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Abstract

This study was carried out to analyse the effect of industrial waste on soil and also to evaluate the soil properties on the receiving soil, in Ilorin. The soil sample was collect from two soils. Soil A, which uses Global soap detergent and Tuyil pharmaceutical discharge as their source of irrigation. Soil B, which uses fresh water for irrigation. The soil sample was collected using the soil auger. The soil samples were tested for their, hydraulic, physical and chemical properties. The result revealed a positive effect on cation exchangeable capacity, available phosphorus, base saturation, while the negative effect on the exchangeable sodium, pH, and organic matter. The positive effect could be attributed to an increase in sand and relative low clay content and lower organic matter content in the soil. I will recommend that the waste water discharged from the industry should be treated before discharge.

TABLE OF CONTENTS

List of tables

List of plates

CHAPTER ONE

1.0 INTRODUTION

1.1 Background of the study

Pollution has always been caused by man and animal in various activities. In the developed world, domestic sewage and industrial sewage e.t.c. are treated at sewage works to reduce the toxicity and then discharged into rivers and streams having met the set standards e.g. 20/30 standards i.e. 20 mg/l (BOD) biochemical oxygen demand and 30 mg/l (SS) set standards. Soil pollution comprises the pollution of soils with materials, mostly chemicals that are out of place or are present at concentrations higher than normal which may have adverse effects on humans or other organisms. It is difficult to define soil pollution exactly because different opinions exist on how to characterize a pollutant; while some consider the use of pesticides acceptable if their effect does not exceed the intended result, others do not consider any use of pesticides or even chemical fertilizers acceptable. However, soil pollution is also caused by means other than the direct addition of xenobiotic (man-made) chemicals such as agricultural runoff waters, industrial waste materials, acidic precipitates, and radioactive fallout. Both organic (those that contain carbon) and inorganic (those that don't) contaminants are important in soil. The most prominent chemical groups of organic contaminants are fuel hydrocarbons, polynuclear aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), chlorinated aromatic compounds, detergents, and pesticides. Inorganic species include nitrates, phosphates, and heavy metals such as cadmium, chromium and lead; inorganic acids; and radionuclides (radioactive substances). Among the sources of these contaminants are agricultural runoffs, acidic precipitates, industrial waste materials, and radioactive fallout.

Plate 1; An area of Karabache, Russia, where soil has been poisoned by high concentrations of lead, arsenic, nickel, cobalt, and cadmium.

Soil pollution can lead to water pollution if toxic chemicals leach into groundwater, or if contaminated runoff reaches streams, lakes, or oceans. Soil also naturally contributes to air pollution by releasing volatile compounds into the atmosphere. Nitrogen escapes through ammonia volatilization and denitrification . The decomposition of organic materials in soil can release sulfur dioxide and other sulfur compounds, causing acid rain. Heavy metals and other potentially toxic elements are the most serious soil pollutants in sewage. Sewage sludge contains heavy metals and, if applied repeatedly or in large amounts, the treated soil may accumulate heavy metals and consequently become unable to even support plant life.In addition, chemicals that are not water soluble contaminate plants that grow on polluted soils, and they also tend to accumulate increasingly toward the top of the food chain. The banning of the pesticide DDT in the United States resulted from its tendency to become more and more concentrated as it moved from soil to worms or fish, and then to birds and their eggs. This occurred as creatures higher on the food chain ingested animals that were already contaminated with the pesticide from eating plants and other lower animals. Lake Michigan, as an example, has 2 parts per trillion (ppt) of DDT in the water, 14 parts per billion (ppb) in the bottom mud, 410 ppb in amphipods (tiny water fleas and similar creatures), 3 to 6 parts per million (ppm) in fish such as coho salmon and lake trout, and as much as 99 ppm in herring gulls at the top of the food chain.

The ever-increasing pollution of the environment has been one of the greatest concerns for science and the general public in the last fifty years. The rapid industrialization of agriculture, expansion of the chemical industry, and the need to generate cheap forms of energy has caused the continuous release of man-made organic chemicals into natural ecosystems. Consequently, the atmosphere, bodies of water, and many soil environments have become polluted by a large variety of toxic compounds. Many of these compounds at high concentrations or following prolonged exposure have the potential to produce adverse effects in humans and other organisms: These include the danger of acute toxicity, mutagenesis (genetic changes), carcinogenesis, and teratogenesis (birth defects) for humans and other organisms. Some of these man-made toxic compounds are also resistant to physical, chemical, or biological degradation and thus represent an environmental burden of considerable magnitude.

1.1.2 Industrial waste

A study was conducted of industrial pollution in lowland rice areas in the district of Rancaekek, West Java. These areas are being polluted by heavy metals from sewage sludge produced by textile industry. This waste is disposed of directly into three rivers, all of which are used to irrigate lowland rice. About 720 ha of lowland rice fields were polluted in this way.

Soil surveys by Kurnia (1999) revealed that there were very high concentration of boron, cadium and lead in three villages in the Kancaekek district. Falling soil productivity in this areas caused a reduction in rice yield and farmers income after 20 years of contermination, the average rice yield had decreased by about 80%. The initial rice yield of about 4-6 mt/ha had become 1 mt/ha. However, the heavy metals content in the soil had increase by about 18%-98%, compared to unpolluted soil.

A greenhouse study using polluted soil from this area showed that high concentration of lead, cadmium, copper, chromium and boron were found in the plant tissue, root and grain of rice. Most of the pollutant had accumulated in the root system. Soil conterminated by heavy metals may pose a treat to human health, if the heavy metal enters the food chain

1.1.3 Soap Industry

Soap is a mixture of sodium salts of various naturally occurring fatty acids. Air bubbles added to a molten soap will decrease the density of the soap and thus it will float on water. If the fatty acid salt has potassium rather than sodium, a softer lather is the result. Soap is produced by a saponification or basic hydrolysis reaction of a fat or oil. Currently, sodium carbonate or sodium hydroxide is used to neutralize the fatty acid and convert it to the salt.

General overall hydrolysis reaction: fat + NaOH ---> glycerol + sodium salt of fatty acid

Although the reaction is shown as a one step reaction, it is in fact two steps. The net effect as that the ester bonds are broken. The glycerol turns back into an alcohol (addition of the green H's). The fatty acid portion is turned into a salt because of the presence of a basic solution of the NaOH. In the carboxyl group, one oxygen (red) now has a negative charge that attracts the positive sodium ion.

1.1.4 Types of Soap

The type of fatty acid and length of the carbon chain determines the unique properties of various soaps. Tallow or animal fats give primarily sodium stearate (18 carbons) a very hard, insoluble soap. Fatty acids with longer chains are even more insoluble. As a matter of fact, zinc stearate is used in talcum powders because it is water repellent. Coconut oil is a source of lauric acid (12 carbons) which can be made into sodium laurate. This soap is very soluble and will lather easily even in sea water. Fatty acids with only 10 or fewer carbons are not used in soaps because they irritate the skin and have objectionable odors.

The cleansing action of soap is determined by its polar and non-polar structures in conjunction with an application of solubility principles. The long hydrocarbon chain is of course non-polar and hydrophobic (repelled by water). The "salt" end of the soap molecule is ionic and hydrophilic (water soluble).

1.1.5 Monolayer:

When soap is added to water, the ionic-salt end of the molecule is attracted to water and dissolved in it. The non-polar hydrocarbon end of the soap molecule is repelled by water. A drop or two of soap in water forms a monolayer on the water surface as shown in the graphics on the left. The soap molecules "stand up" on the surface as the polar carboxyl salt end is attracted to the polar water. The non-polar hydrocarbon tails are repelled by the water, which makes them appear to stand up.

Soap vs. oil vs. water:

Water alone is not able to penetrate grease or oil because they are of opposite polarity.

When grease or oil (non-polar hydrocarbons) are mixed with a soap- water solution, the soap molecules work as a "bridge" between polar water molecules and non-polar oil molecules. Soap molecules have both properties of non-polar and polar at opposite ends of the molecule.

The oil is a pure hydrocarbon so it is non-polar. The non-polar hydrocarbon tail of the soap dissolves into the oil. That leaves the polar carboxylate ion of the soap molecules are sticking out of the oil droplets, the surface of each oil droplet is negatively charged. As a result, the oil droplets repel each other and remain suspended in solution (this is called an emulsion) to be washed away by a stream of water. The outside of the droplet is also coated with a layer of water molecules.

The graphic on the left although not strictly a representation of the above description is a micelle that works in much the same fashion.

Traditionally, soap has been manufactured from alkali (lye) and animal fat (tallow), although vegetable product such as palm oil coconut oil can be substituted for tallow. American colonists had both major ingredients of soap in abundance, and so soap making began in America during the earliest colonial days. Tallow came as a by-product of slaughtering animals for meat, or from whaling. Farmers produced alkali as a by-product of clearing their land; until the nineteenth century wood ashes served as the major source of lye. The soap manufacturing process was simple, and most farmers could thus make their own soap at home.

The major uses for soap were in the household, for washing clothes and for toilet, and in textile manufacturing, particularly for furling, cleansing, and scouring woollen stuffs. Because colonial America was rural, soap making remained widely dispersed, and no large producers emerged. The growth of cities and the textile industry in the early nineteenth century increased soap usage and stimulated the rise of soap-making firms. The effects of "hard" water calcium or magnesium ions are minimized by the addition of "builders". The most common "builder" used to be sodium trimetaphosphate. The phosphates react with the calcium or magnesium ions and keep them in solution but away from the soap molecule. The soap molecule can then do its job without interference from calcium or magnesium ions. Other "builders" include sodium carbonate, borax, and sodium silicates are currently in detergents.

1.2 Statement of problem

As a result of inadequate consumable water, the needs to assess the different sources of water in the locality arise. Also because of the diseases associated with the consumption of contaminated water.

1.3 Aim /Objective of the study

1. To analyse the effects of industrial effluent (waste) on soil, taking river okun as a case study in Ilorin, Kwara state.

1.4 Justification

Treating dirty water, whether it comes from sewage lines or a chemical polluted lake, costs a relative fortune. Sometimes farmers use water from river polluted with sewage or runoff from livestock farms, industry and other contaminated sources to irrigate their cropland. This allows bacteria make it into the harvested crops, and people and animals that live off this produce can become ill. If not properly monitored wastewater reuse affects the fertility of soils and could reduce the quality of produce on agricultural lands. This project is of utmost importance to the society and environment because it explores ways of improving the performance of wastewater reuse for irrigation on the properties of soil.

CHAPTER TWO

2.0 LITERATURE REVIEW

With the ever increasing demand on irrigation water supply, farmlands are frequently faced with utilization of poor quality irrigation water. In many part of Ethiopia, waste water, which is disposed to wells, ponds, streams and treatment plants, are used as a source of irrigation water as well as for drinking (Aletsehage, 2002). But the contained application of poor quality irrigation water can reduce the yield of farmlands water quality for agricultural purposes is determined on the basic of the effect of water on the quality and yield of crops, as well as, the effect on the characteristic change in soil (FAO, 1985). The most commonly encountered soil problems used as a basis to evaluate water quality are those related to the salinity, water infiltration rate, toxicity and a group of other miscellaneous problems (Richardson, 1954, Wilcox 1966). The existing industries have been discharging their waste into the surrounding environment in particular to the near by river. According to the local woreda agriculture office, more than 25,000 farmers are diverting the effluent contaminated river water to irrigate about 2695 ha of farmlands in order to grow different crops including cereals, vegetable and fruit (Kalu Woreda Agricultural office, 2006). In addition, the latest report from the local agricultural administration office explains that despite the fact that many farmers and enterprises have used Local River for irrigation since long time ago. No study has been conducted yet on the chemistry of the polluted river water for its irrigation on suitability (Kalu Woreda Agricultural office 2007).

For quite sometime now the issue of development vis-à-vis environmental protection has become one problem that has continued to generate heated debate, especially in developing countries. This is so because, first environmental quality itself is part of the improvement in contamination include runoffs, agrochemicals such as pesticides and nitrates used on farm land and industrial effluents. Contamination of soil due to seepage has reported in the Niger Delta area of Nigeria (Ibe and Agbamu, 1999). Arising from the drive for industrialization, parts of Ilorin town are designated industrials areas to accommodate the industries. One of such industrial area has the course of River Okun running through it whole length. The river is flows through Ilorin town almost dividing it into two halves (Olayemi 1994). This makes it readily prone to abuse as effluent receptacle leading to contamination. Studies have shown that the rivers water quality is affected by the discharge of the effluents (Eniola and Olayemi, 1999). This is consistent with the observation of Sangodoyin (1991) the effluents discharge alters the physical, chemical and biological nature of the receiving water body. Increasing waste production by human activities has increased the problems of how to get rid of it without causing undesirable impact on the environment and human health. Traditional approaches, incineration land filling, for remediation of toxic heavy metal contaminated soil are typically expensive, labor intensive and environmentally inefficient. In principal land disposal is more popular than other means including landfills, incineration and dumping at sea, because it is relatively inexpensive. Unfortunately, land disposal of these wastes is a potential risk for human safety due to inorganic pollutants such as heavy metals borne in these wastes. Concern about metal contamination of soils relates directly to the extent to which natural background levels are exceeded and to the monthly of these metals in terms of bioavailability to plants and the movement to ground water.

It has been generally assumed that since heavy metals are strongly bound by the soil, leaching of metals downward into ground water is not an environmental issue. However, in recrnt years, this assumption is challenged and metal leaching from sludge treated soil has been observed in several studies. Heavy metals are associated with various soil components in different ways and these associations indicate their mobility in soils as well as their bioavailability (Al-Oud, 2000; Al-wabel and El-maghraby, 2006). The degree of metal association with different chemicals forms depends on soil properties such as pH, organic matter, redox condition and texture (Zhang et al., 1997).

Land application of boi-solids and industrial wastes can significantly increase heavy metals concentrations in agricultural soils. Fields studies have generally shown no difference in heavy metals concentration below 30 cm between treated and untreated soil with bio-solids (Chang et al., 1982, 1983; Dowdy and Volk, 1983; Williams et al., 1985; Al-Oud, 2003; Zheijazkov and Warman, 2004). However, leaching of some heavy metals to 60 cm depth can occur when large amount of liquid sewage sludge are applied (Robertson et al., 1982). Fuller (1997) reported Cd to be fairly mobile in soils of pH 4.6 to 6.6 and moderately mobile in soils with pH range 6.7-7.8. Sanchez-Martin and Sanchez-Camazano (1993) in their study concluded that Cd was slightly mobile in 27% moderately mobile in 14%, mobile in 41% and highly mobile in 18%. They further reported that, the pH, exchangeable bases and clay content of soil have a significant effect on Cd mobile. Scokart et al. (1983) observed higher accumulation of Cd and Zn in loamy soils than for sandy soils even though they have the same CEC. According to Elliot and Denneny (1982), the addition of organic rich waste such as municipal sludge and industrial wastes can provide enough organic matter to the soils to bind toxic heavy metals like Cd, Zn and Pb. Also Kabala and singh (2001) and Zheljazkov and Warman (2004) reported that organic matter had high ability to absorb or complex many metals. In addition, adsorptions on hydrous oxides of iron and cation exchange reaction are important modes of metals immorbility (Pilar et al., 2006). In most cases, the metals are present in an immobile form at the time they are added to the soil. Heavy metals are associated with various soil components in different ways and these associations indicate their mobility in soils as well as their bioavailability, (Tania et al., 2003) and Zheijazkov and Warman (2004) pointed out that, hydrosoluble and exchangeable fraction are considerable are considered readily mobile and bioavailable.

The concern over soil contamination stems primarily from health risks, from direct contact with the contaminated soil, vapors from the contaminants, and from secondary contamination of water supplies within and underlying the soil. Mapping of contaminated soil sites and the resulting cleanup are time consuming and expensive tasks, requiring extensive amounts of geology, hydrology, chemistry and computer modeling skill.

It is in North America and Western Europe that the extent of contaminated land is most well known, with many of countries in these areas having a legal framework to identify and deal with this environmental problem. This however may well be just the tip of the iceberg with developing countries very likely to be the next generation of new soil contamination cases. The immense and sustained growth of the peoples Republic of China since the 1970s has exacted a price from the land in increased soil pollution. The State Environmental Protection Administration believes it to be a threat to the environment, to food safety and to sustainable agriculture. According to a scientific sampling, 150 million mi (100,000 square kilometers) of China cultivated land have been polluted, with contaminated water being used to irrigate a further 32.5 million mi (21,670 square kilo) and another 2 million mi (1,300 square kilometers) covered or destroyed by soil waste. In total, the area account for one-tenth of China cultivated land, and is mostly in economically developed areas. An estimated 12 million tones of grain are contaminated by heavy metals every year, causing direct losses of 20 billion yuan (US$2.57 billion), (Wikipedia, 2009).

2.1 Previous Report in the Literature

There has been various reported observation on the effect of wastewater reuse for irrigation on the properties of soil. Such reports that have been encountered are presented thus;

In 2003, Tamimi carried out a study on 'wastewater characterization and the reuse of recycled effluent in irrigating agricultural crops'. He reported that effluent contains high amounts of dissolved solids concentration and other constituents that affect soil, crop and the environment. To avoid the negative effect, he stated that proper irrigation management systems are required to prevent soil deterioration and reduction in yield. The author discussed the procedure and methods used for characterization of wastewater, the different parameters used to determine the quality of recycled water and the effect of recycled effluent on soil, crop and the environment. He concludes that the continuous reuse of wastewater in agriculture can have devastating results on the soil, environment and public health. However, appropriate data collection, analysis designs, testing, evaluation then implementation of the best suitable system is the proper course of action that is needed to be taken when considering such a problem.

Bello (2008) in 'the effect of laundry wastewater on soils properties' aimed at estimating and studying the effect of laundry wastewater on properties of the receiving soil. He carried out analysis of the wastewater by subjecting them to physical, chemical and biological test. He stated that surfactants in laundry detergents have a greater negative impact on the soil hydraulic conductivity. The author concluded that advance treatment of the effluent using ultraviolent radiation method should be introduced into the system in order to improve the quality of the effluent that is being discharged in to the following stream.

In 2008, Sheidu described an investigation on the 'effect of wastewater from carwash on soil hydraulic properties'. The author investigated the effect of wastewater from carwash on soil hydraulic properties and compared the result with the FAO standard for irrigation water in order to know the level of contamination. He discovered that the values gotten from the analysis of the wastewater from carwash are above the limit of the FAO standards.

2.2 Health effects

Contaminated or polluted soil directly affects human health through direct contact with soil or via inhalation of soil contaminants which have vaporized potentially greater threats are posed by the infiltration of soil contamination into the groundwater aquifers used for human consumption, sometimes in areas apparently far removed from any apparent source of ground contamination. Health consequences from exposure to soil contamination vary greatly depending on pollution type, pathway of attack and vulnerability of the exposed population. Chronic exposure to chromium, lead and other metals, petroleum, solvents and many pesticide and herbicides formulation can be carcinogenic, can cause congenital disorders or can cause other chronic health conditions. Industrial or man-made concentrations of naturally occurring substances, such as nitrate and ammonia associated with livestock manure from agricultural operation have also been identified as health hazards in soil and groundwater.

Chronic exposure to benzene at sufficient concentrations is known to be associated with higher incidence of leukemia. Mercury and cyclodienes are known to induce higher incidences of kidney damages, some irreversible. PCBs and cyclodienes are linked to liver toxicity. Organophosphates and carbanamates can induce a chain of responses leading to neuromuscular blockage. Many chlorinated solvents induce liver changes, kidney changes and depression of the central nervous system. There is an entire spectrum of further health effects such as headache, nausea, fatigue, eye irritation and skin rash for the above cited and other chemicals. At sufficient dosages a large number of soil contaminants can cause death by exposure via direct contact, inhalation or ingestion of contaminants in groundwater contaminated through soil.

2.3 Ecosystem effects

Not unexpectedly, soil contaminants can have significant deleterious consequences for ecosystems. There are radical soil chemistry changes which can arise from the presence of many hazardous chemicals even at low concentration of the contaminant species. These changes can manifest in the alteration of metabolism of endemic microorganisms and arthropods resident in a given soil environment. The result can be virtual eradication of some of the primary food chain, which in turn have major consequences for predator or consumer species. Even if the chemical effect on lower life forms is small, the lower pyramid levels of the food chain may ingest alien chemicals, which normally become more concentrated for each consuming rung of the food chain. Many of these effects are now well known, such as the concentration of persistent DDT materials for avian consumers, leading to weakening of egg shells, increased chick mortality and potential extinction of species.

Effects occur to agricultural lands which have certain types of soil contamination. Contaminants typically alter plant metabolism, most commonly to reduce crop yields. This has a secondary effect upon soil conservation, since the languishing crops cannot shield the Earth's soil mantle from erosion phenomena. Some of these chemical contaminants have long half-lives and in other cases derivative chemicals are formed from decay of primary soil contaminants, (from Wikipedia, the free encylopedia).

2.4 Irrigation

Irrigation is defined as artificial application of water to arid land for growing crops, (Sharma, 2007). It is a profession as well as a science. A crop requires certain amount of water at certain fixed intervals throughout its period of growth. Irrigation is not required if this requirement is met with from sufficient rainfall. In tropical countries the first two of the three essential requirements of plant growth, that is, heat and light are available in abundance, but the third, that is, moisture needs to be supplemented frequently by artificial application of water. Thus, irrigation is supplementary to rainfall when it is either deficient or comes irregularly or at unreasonable times. The management of water supply and sanitation is practiced since at least 500 years ago in Egypt. At that time, it was a challenge how to make use of flash floods. Like today, agriculture was the major water consuming sector and therefore ancient Egyptians focused mostly on irrigation. An ancient Egyptians had only one season in which they cultivated the lands which were enough since the population was much lower than today, (Hussam, 2009).

Irrigation is now successfully employed around the world by many vegetable growers, to assist in the production of high-value crops such as cauliflower, spinach, lettuce, onions, tomatoes, etc. It is used for watering-in the plants, and for maintaining a luxurious growth in times of drought, (Sharma, 2007).

2.4.1 Need for irrigation

As already mentioned, unless rainfall is sufficient to meet the water requirement of crop throughout their period of growth, need for irrigation water is unavoidable. The necessity for irrigation may thus be summarized as

1. Deficient rainfall; when rainfall is less than 100cm, irrigation water is essentially required. Rainfall deficiency vis-a-vis irrigation requirement by crops can be briefied as follows.

Rainfall (cm)	Irrigation requirement
100	rainfall needs to be supplemented by irrigation.
100-50	rainfall is insufficient. Irrigation is essential.
50-25	Irrigation is essentially required.
Less than 25	No crop can be grown without irrigation.

2. Non-uniformity of rainfall; where rainfall is sufficient but not uniform, concentrated as it usually is in monsoon months, there is acute requirement of irrigation in other periods.
3. Augmentation of crop yields; new high yielding varieties of crops have higher water requirement for giving higher yields. Sugarcane and rice have higher requirement of water.
4. Extracting water requirement; the high yielding varieties of crops have more extracting requirement of water.
5. Cash crops cultivation; cash crops require higher and assured supply of water with frequent watering for maturity.

2.5 Irrigation methods

The design, equipment and technique of replenishing the soil by applying irrigation water is referred to as irrigation method. The primary objective of any irrigation method is to supply water to soil so that moisture will be readily available at all times for crop growth but without indiscriminately adding to the water table, as well as avoiding influence on soil salinity. The method of applying irrigation water may be classified as surface, subsurface, sprinkler and trickle irrigation.

2.5.1 Surface irrigation

This is by far the most common type of irrigation. In surface irrigation method, since water is applied to the field in varied quantities and at different times, the flow remains unsteady. The method involves diverting a stream of from the head of a field into furrows or borders, and allowing it to flow downward. Water infiltrates into the soil while transversing the furrow. By subsequent ponding and lateral movement, the soil is restored to its full water holding capacity to a depth that depend on the quantity of water introduced, the duration and the rate of stream flow, the gradient and the soil structure and texture. Highly efficient irrigation can be achieved by an appropriate combination of size of the irrigation stream, uniform application of water, minimum soil erosion, minimum labour requirement, maximum land use, size and shape of field and use of machiner, (Sharma, 2007).

2.5.2 Subsurface Irrigation

In sub-surface or sub-irrigation, water is applied beneath the ground by creating and maintaining an artificial water table at some depth, usually 30-75 cm, below the ground surface. Moisture moves upward towards the land surface through capillary action to meet requirement of the crops in plant root. Water is applied through underground distribution system. Water may be obtained from wells, streams, lakes, etc. Water is introduced into soil profile through open ditches, moles drains. Sub-surface irrigation requires little field preparation and labour. It entails minimum evaporation loss and surface waste. The irrigation water is essentially required to be of good quality to prevent excessive soil salinity. The flow rate in supply ditches is required to be low to prevent water logging of the field. The use of sub-irrigation is limited because it requires certain soil condition that is the soil is permeable in root zone, underlain by an impervious horizon or high water table, (Sharma, 2007).

2.5.3 Sprinkler Irrigation

In sprinkler irrigation system, water is pumped under pressure, carried through high pressure main line and let out through sprinkler nozzles placed at regular intervals on laterals on lateral lines to form a gentle rain. The system is designed considering agro-climatic conditions, general land condition, maximum difference in elevation, cropping pattern as different require different amounts of water and different irrigation schedules, cover-crop requirements and their effect on peak water use, requirement and rates, availability of labour, matching pump and power unit, pipe sizes economical to install and operate, water supply source, quantity and quality as essentially clean and debris-free water is required. Considering these factors, the system is so designed that it delivers the right amount of water with optimum rate of application, depth of application and period of application. (Sharma, 2007).

2.5.4 Trickle Irrigation

This is also known as drip irrigation. It is the latest developed method of irrigation and was first introduced in Israel. Water is applied at low rate and is often to individual plants. This is accomplished through the use of specially designed emitters or porous tubes. This system provides an opportunity for efficient use of water because of minimum evaporation losses and because irrigation is limited to the root zone due to high cost, their use is generally limited to high value crops. Since the distribution pipes are usually at or near the surface, operation of the field equipment is difficult. This method is particularly suited to soils with very low and very high infiltration rates under the conditions of water scarcity and in areas where drainage of excess water is difficult. It is most successful for high income crops because of the relatively high first cost of instillation. Both sprinkler and trickle system are well adapted to application of agricultural chemical, such as fertilizer and pesticides with the irrigation water, (Sharma, 2007).

2.6 Effects of Irrigation

Irrigation is to agriculture as blood is to human body. Introduction of irrigation results in changes in vegetation, the fauna and the flora thereby altering the ecology of the command area. These improvements have added advantage of a chain reaction in many spheres which lead to a more prosperous life for the people of the area. Lands which where once barren, infertile with activity with green pastures, verdant forest and teeming population. The human environment too changes as a result thereof. Development of irrigation is alone effective in combating the natural disasters like droughts and the single most promising short and long term means of reducing poverty and generating employment. Irrigation has brought about stability in agricultural production and has made significant contribution in the attainment of self sufficiency in food and hence agricultural independence. All reforms mooted in agriculture will not bear fruit if irrigation facilities are not there to fructify them. Irrigation is an instrument of national integration by developing backward and barren areas and thereby bringing them into national main stream.

2.7 Irrigation with wastewater

Agricultural irrigation has by far been the largest reported reuse of wastewater. Four main reasons are responsible for the fast growth of wastewater use for irrigation.

- Reclaimed water serve as an extra source of water available for the rural sector for irrigation. This source is specially important in regions with limited water resources, where the increasing water demand by the urban sector (usually due to a combination of population growth and increasing living standards) is replenished by reducing the water supply to agricultural sector. The supply of treated wastewater is quantitatively reliable for the farmers, since it depends neither on precipitation nor on the water balance of the whole region.
- Irrigation adds significant polishing treatment to the effluents via break-down of xenobiotic compounds in the soil, evaporation of volatile compounds, pathogens die-off, biological degradation of remaining organic matter, and other processes.

- Surprisingly, disposal of the treated effluents via irrigation may be the cheapest disposal alternative (for both construction and operational costs) when compared with disposal via discharge to rivers or lakes.
- Disposal of the treated effluents via irrigation may also be the alternative with the minimal impact on the environment.

Irrigation has the advantage of "closing-the-loop" combination of waste disposal and water supply. Irrigation reuse is also more advantageous, because of the possibility of decreasing the level of purification, and hence the savings in treatment cost, thanks to the role of the soil and crops as biological treatment facilities. However, national policy calls for the gradual replacement of freshwater because of the decision to increase the use of effluent and set up a committee to review existing regulations and recommend new regulations for effluent use for irrigation or disposal to stream and receiving water.

It is important that the community as a whole should become more involved in the working of reuse system.

2.8 Waste Treatment

The methods of treatment in which the application of physical forces predominant are known as unit operations. The methods of treatment in which the contaminates is brought about by chemical or biological reactions are known as unit processes. Unit operations and processes are grouped together to provide various forms or levels of treatment known as preliminary, primary, advance primary and secondary treatment. In preliminary treatment, gross solid such as rags, sticks, floatable and grit that may cause maintenance or operational problems with the treatment operations are removed. In primary treatment, a physical operation usually sedimentation is used the process of decay and decomposition of rock proceeds through three recognizable stages. These three stages appear as a series of zones in any sections of the soil. These zones are layers approximately parallel to the soil surface and collectively constitute soil profile. The three zones beginning from the surface downward, are discussed below.

I. Zone A;- it is a zone of leaching and decomposition in which the minerals and organic matters are decomposed and converted into colloids. It is characterized by finely divided particles extending from a few centimeters to 60 cm below the surface. It is zone in which the grass root, etc, are embedded. It contains humus in most region. The zone has maximum biological activity.

II. Zone B;- it lies immediately below zone A. it a zone of decomposition. It extend from a few centimeter to 100 cm thickness. It varies from zone A in colour, structure, clay content and organic matter. Organic is low and the main size is rather coarse.

III. Zone C;- it is layer of unconsolidated material like decomposed rock or freshly deposited alluvium. It is characterized by a coarse grained, rather pebbly texture, making a transition between solid rock and finally decomposed rock. Roots penetrate into this zone. It extends usually up to 2m in thickness, (Sharma, 2007).

2.9.2 Soil colour

Soil colour is one of the most useful and important characteristics for soil identification. Colour of the soil depends upon its composition, drainage condition, porosity and age. Concentration of the organic matter imparts a grey, black or dark-brown colour to the soil. Diffusion of iron oxides imparts red and yellow colour to the soil. Manganese dioxide and hydrate iron oxides may also contribute red colour. A light grey colour may indicate a very low content of organic matter and iron. Soil colour changes with moisture content and effective drainage.

2.9.3 pH value of soils

pH value or hydrogen ion concentration is a measure of the intensity of acidity or alkalinity of a soil. Its value ranges from 0 to 14, of which 7 is neutral in the sense of chemical reaction. Below 7, the soil is acidic, above 7 it is alkaline. Soil productivity increases as pH approaches neutrality. Most irrigation soils have pH ranging between 6.0 and 8.5.

2.9.4 Soil Textures

The size of particles comprising the soil determines its texture. The texture of a soil is perhaps its most nearly permanent characteristic, although soil structure can be quickly modified by management. The texture commonly refers to the fineness or coarseness of soil as a whole as to the proportion of the particle groups of different sizes. It is controlled by climate and mineralogical composition of the rock. The texture of soils is commonly described by size limits also known as' particle size.'

The three textural types of soil generally recognized are sandy soil (>50% sand particles), silt soil (>50% silt particles) and clayey soil (>50% clay particles). Loamy soil has mixed particles of sand, silt and clay.

2.9.5 Soil structure

It signifies the arrangement of soil particles, sand, silt, clay, organic matter etc. Unlike texture, soil structure is not permanent but with cultivation practices the top soil becomes granular. The soil structure is important to soil productivity, soil permeability, root growth and soil genesis. The common types of soil structure are granular, prismatic, blocky and massive. Fine grained soil have granular structure in which water entry is rapid with better seed germination and as such are desirable for irrigation as large voids provide space for circulation of air. In prismatic structure the movement of water is mainly vertical and as a result the water supply to the root is poor. In top soil, massive structure blocks the entry of water, seed germination is difficult and aeration is poor. In blocky top soil, water entry is moderate. From the stand point of agriculture, favorable soil structure is the key to soil fertility, [Sharma, 2007].

2.9.6 Soil Organic Matter

All soil contain living organisms, the majority of these organism are too small to be seen with naked eyes. When plant residues are turned into the soil they are subjected to rapid bacteria attack and much of the organic matter is lost to the air as carbon dioxide. However a residue of dark color material remains which is called 'humus' or soil organic matter. The amount of organic matter in a soil depends on several factors. The most important being the supply of air. When aeration is restricted due to poor drainage, the break down of plants remain by bacteria and other soil organisms is inhibited. So wet soil are normally rich in organic matter and well aerated soil contains much less, (Sharma, 2007)

2.9.7 Soil Moisture Content

This is the ratio of the volume of contained water in the soil compared with the entire soil volume. When a soil is fully saturated, water will drain easily into the underlying unsaturated rock. When such drainage stops, the soil still retains capillary moisture and is said to contain its field capacity moisture content. Further drying of the soil, for example by evaporation created a soil –moisture deficit, which is the amount of water that must be added to the soil to restore it to field capacity measured as a depth of precipitation.

2.9.8 Bulk Density

It is defined as the mass of many particles of the material divided by the total volume they occupy. The total volume includes particle volume, inter-particle void volume and internal pore volume. Bulk density is not an intrinsic property of a material; it can change depending on how the material is handled.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Description of the Study Area

The study carried out within the industrial estate located in Ilorin, North Central Nigeria (8^0 28'N, 4^0 38'E 31'N, 4^0 40'E). It houses the major industries in the town: Global soap and Detergent, unifoam, 7up Bottling Company, Tuyil pharmaceuticals and Nigeria Bottling Company. The study was on Okun Stream, the stream runs from global detergent area past Tuyil pharmaceuticals. The stream eventually drains into Asa Dam. Water from Asa dam is mainly used for capture fisheries by locals and irrigation purposes by many farmers. The major industries discharging effluents into the stream are the global soap and detergent industry and Tuyil pharmaceuticals.

3.2 Experimental Procedure

The soil samples were collected from two different sources (Soils). The soil A, which uses the Tuyil pharmaceuticals and the Global soap discharge as there source irrigation and soil B, which uses fresh water for irrigation . The soil samples were collected with the help of the instrument called the soil auger. The soil auger was deep into each field three times to collect samples then put in a nylon and taken to the laboratory. The depth of the soil was 0-30cm, and was collected on the 17th of June, 2010.

Table 1; method soil sample was collected from the field, using soil auger

S/N	LAB NO	FIELD NO	SAMPLE POINT	HORIZON (CM)	REMARKS
1	1	A	1-3	0-30	FALLOW
2	1	B	1-3	0-30	FALLOW

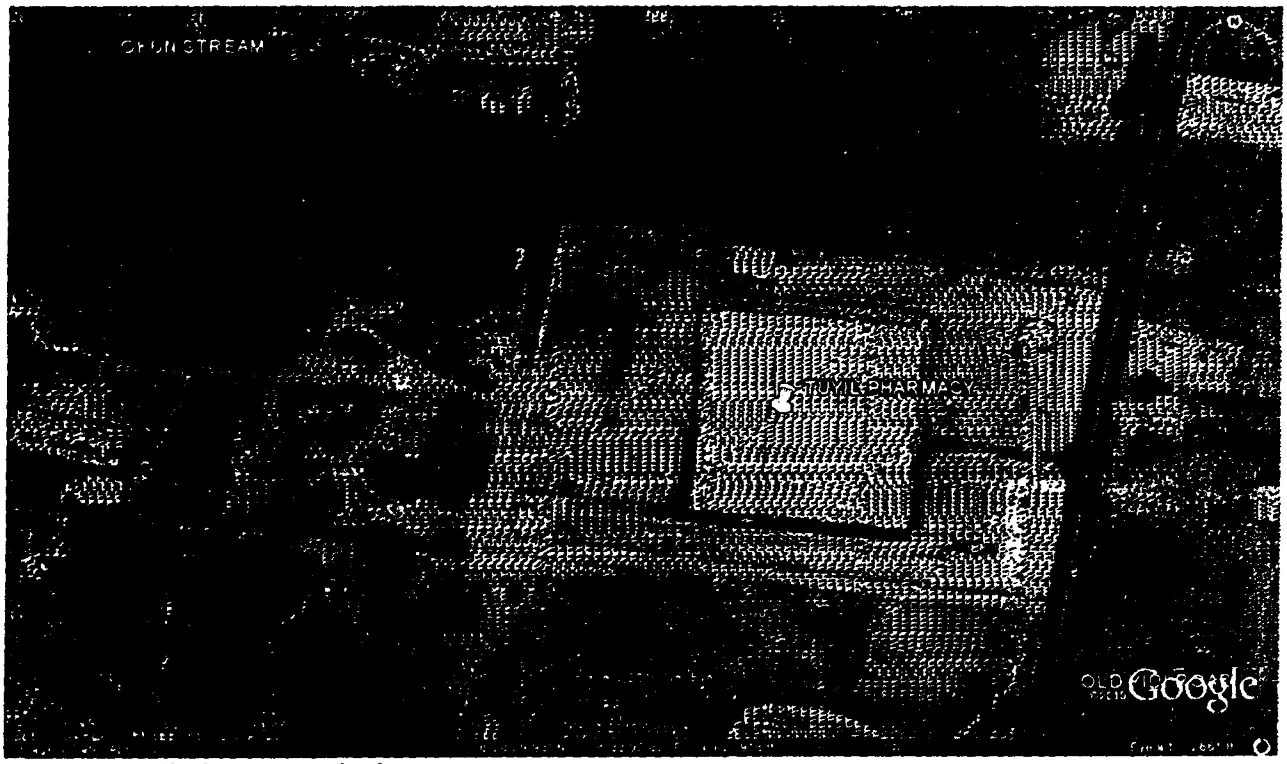

Plate 2; Tuyil pharmaceutical

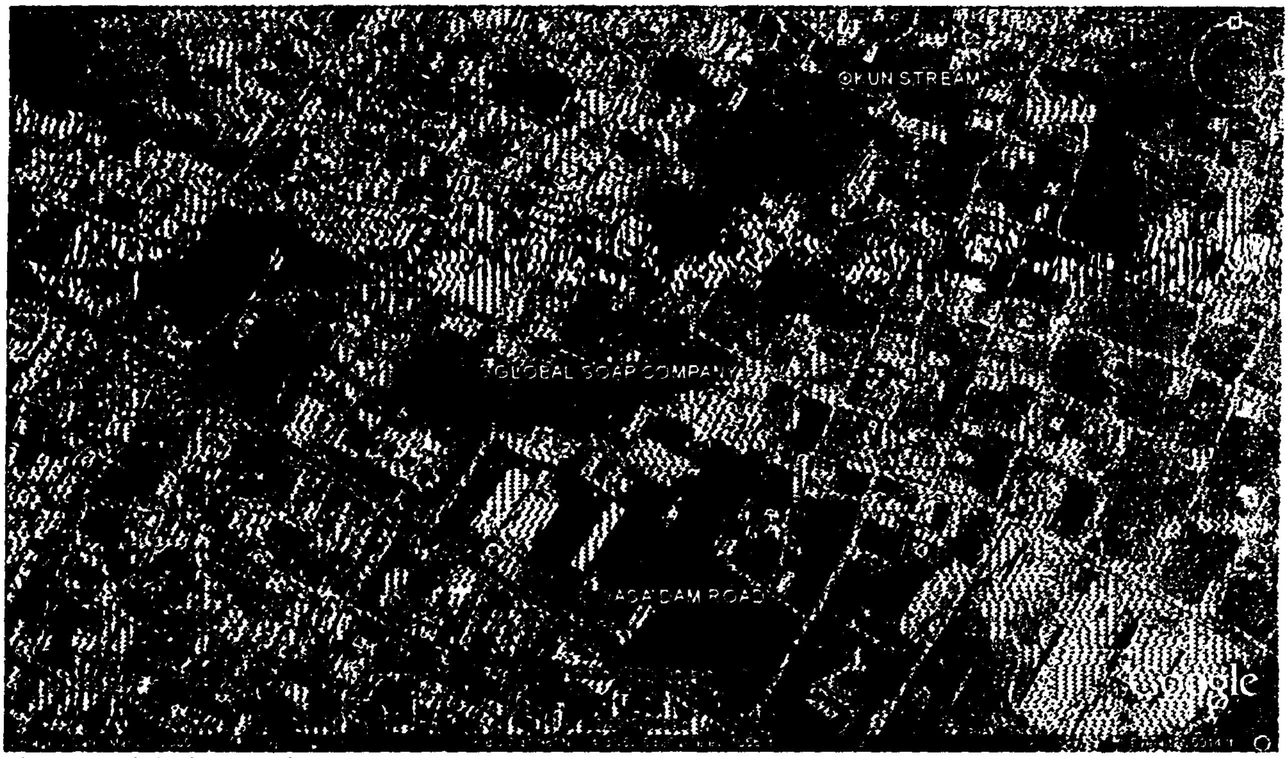

Plate 3; Global Soap detergent

3.3 Materials used for the Experiment

There are various materials used for the experiment which range from simple equipment to complex equipment used for the soil analysis.

The tools used for soil analysis include; standard hydrometer, electric stirrer, plunger, cylinders amyl alcohol and calgon solution for particle size analysis; acetic acid, ammonia solution, (NH_3), ammonium acetate, NH_4OAc (pH 7) extracting solution, ethanol washing solution and NaCl extracting solution used for the determination of exchangeable cations.

3.4 Soil analysis

3.4.1 Determination of particle size analysis by hydrometer method

Two millimeter (2mm) air dried soil and 50g of the sample was weighed, 100ml of distilled water was added to the sample in a bottle and 5% sodium hexametephosphate solution which serve as an dispersing agent was added. The mixer was placed in a shaker and the shaker content was transferred quantitatively without loosing any particle into the sedimentation cylinder, up to 1 liter marked with distilled water. The soil sample was disturbed with the aid of a plunger for proper soil suspension. The hydrometer was immersed into the sample and the stop watch was used to take reading. The temperature of the suspension was also taken by immersing the thermometer into the sample. The 40 seconds reading was also taken to measure the percentage silt and clay in suspension. A blank sample was also prepared but without soil and the reading also obtained.

3.4.2 Soil pH Measurement using Soil Testing Kit

A little quantity of barium-sulphate was put into the test tube provide in the kit closed at one end. The soil which had been sieved through 2mm sieve was added in a little quantity, distilled water was then added to reach the lower mark and soil indicator was added to reach the upper mark. The upper end was closed with a cork. The mixture was stirred and allowed to stand for about 30 minutes. The pH was determined by carefully comparing the solution with the standard chart.

3.4.3 Determination of Soil Organic Matter

The soil sample was grinded into fine powder; 1g soil sample was weighed out in duplicate and transferred to 250ml conical flask. 10ml of $K_2Cr_2O_7$ was then rapidly added and the flask was gently swirled until soil and reagent were mixed. After standing for 30 minutes, 100ml of distilled water added. 3-4 drops of ferroin was also added and then titrated with 0.5M iron (11) ammonium sulphate. A blank titration was made in the same manner but without soil. The reaction $K_2Cr_2O_7$ oxidation carbon and the excess $K_2Cr_2O_7$ was titrated with iron (11) solution. The result was obtained and recorded.

3.4.4 Exchangeable Cation Determination

The leaching tube was prepared with the correct filter paper and Buchner flask with suction pump. 10g of air dry soil weighed into the 250ml beaker and 100ml of NH_4OAc was added and shaken for 1 hour using mechanical shaker. The content in the beaker was transferred to the Buchner flask and filtered with the suction pump. The soil residue was washed by leaching with 100ml 95% ethanol with about 20ml at a time to remove the excess NH_4+, the leachate is discarded. The soil is leached with 100ml of 1M NaCl into volumetric flask. NH_4+ is then determined in the leachate as a measures of the cation by distillation.

3.4.5 Determination of Soil Textural Classes

The mineral particle in the soil is divided into the following size classes;

- Coarse fragments (gravel,cobbles,stones) larger than 2mm
- Sand .05 to 2mm
- Silt .002 to .05

- Clay smaller than .002

To put these in perceptions, if a particle of clay were the size of a BB, then a particle of silt would be about the size of a golf ball, and a grain of sand would be about the size of a chair. Sand, silt and clay are referred to as soil seperates.

Sand is gritty when wet or dry. Sands are the smallest soil particles you can see with the naked eye. Silt is smooth and floury when dry and it is greasy when wet. Clay exhibits both cohesion (it sticks to itself) and adhesion (it sticks to other things).

Texture is a word used to describe how something feels. Soil texture refers to the relative proportion of each of the soil seperates in a specific soil or horizon (layer) in the soil, because this determines how soil feels. The texture triangle is used to determine which texture class a soil belongs to, based on the specific amounts of sand, silt and clay it contains.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Results of the soil Analysis

The results of the soil analysis are given in the table below;

Table 4.1 soil analysis

Parameters	Units	Soil A	Soil B
Depth of horizon	Cm	0-25	0-25
Organic carbon walkley & black	%	0.37	0.20
Organic matter	%	0.34	0.63
PH- water (suspension 1:2)	pH	5.40	5.68
PH- Kc 1 (suspension 1:2)	pH	5.80	5.50
EC- 2 (Extract 1:2)		0.00	15.00
Exchangeable cations Ca	Cmol/Kg	6.40	10.10
Exchangeable cations Mg	Cmol/Kg	4.00	3.50

Exchangeable cations K	Cmol/Kg	0.31	0.26
Exchangeable cations Na	Cmol/Kg	0.62	0.48
Exchangeable acidity	Cmol/Kg	0.16	0.08
Cations exchangeable capacity C.E.C	Cmol/Kg	10.44	14.14
Base saturation percent	%	98.5	99.6
Exchangeable sodium percentage E.S.P	%	6.7	5.56
Available phosphorus (Bray 1)	Ppm	8.75	6.71

Soil A; Soil that uses Global soap detergent and Tuyil pharmaceutical effluent as source of irrigation.

Soil B; Soil that uses fresh water as source of irrigation.

4.2 Discussion of Result

4.2.1 Organic matter

The soil organic matter percentage of soil A is 0.34 while that of soil B is 0.63. It was observed that the organic matter of soil A is less than that of soil B. It was observed that the dissolved organic matter in the wastewater had a positive effect on the soil hydraulic conductivity. This was due to less suspended material in wastewater.

4.2.2 Soil pH

The soil pH was lower in soil irrigated with waste water than the soil irrigated with fresh water. The average soil pH is 5.68 and 5.49 for PH- water while for PH-Kc 1 is 5.80 and 5.50 respectively. The decreace in the soil pH from neutral to acidity suggest an decrease in the soil properties. However to avoid the negative effect, a proper disposal management system is required to prevent soil deterioration.

4.2.3 Exchangeable sodium

The soil irrigated with wastewater exhibit a lower concentration of exchangeable sodium (Na) than the soil irrigated with fresh water, which have the values of 0.62Cmol/Kg and 0.48Cmol/Kg respectively. The low sodium content reflected the low sodium concentration in the wastewater of 35.1mg/l. This reduction in concentration of exchangeable sodium inceased the hydraulic properties of the soil.

4.2.4 Magnesium content

The magnesium content for soils with wastewater is 4.00Cmol/Kg and 3.50Cmol/Kg for fresh water. The decrease in magnesium content reflected the replacement of magnesium with sodium and calcium, and since calcium has much higher absorption affinity than magnesium. The reduction in the magnesium content of soil increased the soil properties.

4.2.5 Exchangeable sodium percentage E.S.P

The exchangeable sodium percentage is 6.7 and 5.56 respectively. This was due to the regular amendment with calcium (ca) products. This wastewater has a positive effect on infiltration capacity.

Table 4.2 Result of particle size analysis

Parameters	Units	Soil A	Soil B
Sand	%	58.00	49.00
Silt	%	22.00	14.00
Clay	%	20.00	37.00

Table 4.2 shows the result of the particle size analysis of the soils from the soil that uses wastewater (soil A) and the soil that uses fresh water for irrigation (soil B). The percentage soil particle composition of soil A, are as follows; 58.00% sand, 22.00% silt, and 20.00% clay. This falls into the soil textural triangle. The corresponding soil textural class is sandy clay loam. The

percentage soil particle compositions of soil B, are as follows; 49.00% sand, 14.00% silt, and 37.00 clay. The corresponding soil textural class is silt clay loam.

Comparing the percentage composition of the soils; the percentage of sand decreased from soil A to soil B and as a result, soil B will transmit water than soil A, due to higher clay fraction in the soil B, it will also hold water than soil A.

CHAPTER FIVE

5.0 Conclusion and Recommendation

5.1 Conclusion

Base on the result of the soil analysis, the effect of use of wastewater for irrigation had both positive and negative impact on the hydraulic properties of soil. The positive impact was due to the pH, temperature and sodium concentration of the industrial wastewater. However, proper management of soil, water and operational procedures play an important role in the successful use of sewage effluent for irrigation. This led to the development of the guidelines proposed in this research for the effective use of wastewater for irrigation and are presented in relation to the field management practices in wastewater irrigation where applicable.

The guidelines developed form a basis for further consultation involving interested researchers and they include; blending of wastewater with other water supplies, alternating treated wastewater with other water sources, land development, land grading, timing of irrigation and deep cultivation.

5.1.1 Alternating treated wastewater with other water sources

Another strategy is to use the wastewater alternatively with the canal water or ground water, instead of blending. From the point view of salinity control alternate application of the two sources will be superior to blending. However an alternating application strategy will require dual conveyance system and availability of the effluent dictated by the alternate schedule of application.

5.1.2 Land Development

During the early stages of on-farm land development, steps can be taken to minimize potential hazards that may result from the use of wastewater. These will have to be well planned, designed and executed since they are expensive and often one time operation. Their goal is to improve permanently existing land and soil condition in order to make irrigation with wastewater easier. Typical activities include leveling of land to a given grade, establishing adequate drainage, deep ploughing and leaching to reduce soil salinity.

5.1.3 Land Grading

Land grading is well accepted as an important farm practice in irrigated agriculture. It is of great significance in achieving good uniformity of application from surface irrigation methods and acceptable irrigation efficiencies in general. Several methods are available to grade land to a desired slope. The slope required will vary with the irrigation system, length of run of water flow, soil type and the design of the field.

5.1.4 Timing of Irrigation

The timing of irrigation including irrigation frequency, pre-planting irrigation and irrigation prior to a rainy season can reduce soil deterioration and improve the hydraulic properties of soil. Pre-planting irrigation is practiced in many irrigation schemes for two reasons, namely (1) to leach salts from the soil surface and (11) to provide adequate moisture to germinating seeds and young seedling.

5.2 Recommendation

- More research should be carried out on different soil types and at various depths to see the effects of the hydraulic properties of soil.
- The analysis should be carried out in different laboratories and the results compared to ensure accuracy.
- More research should be carried out in both seasons to see whether there will be much variation in the values obtained in both seasons.

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