Effect of Irrigation Water Quality on Soil Structure Along Asa River Bank, Ilorin Kwara State

O.N. Ajala, J.O. Olaniyan, K. Affinnih, H.E.Ahamefule

Department of Agronomy University of Ilorin, Ilorin. Nigeria.
Corresponding Author: O.N. Ajala, e-mail: segnathorg@gmail.com

Abstract

Good soil structure is an essential element of healthy and sustainable agro-ecosystems. It promotes the development of extensive plant root systems and efficient use of water and nutrients. An experiment was carried out with the objective of evaluating the effect of irrigation water quality on soil structure, it was conducted in a two way factorial with four (4) locations selected along the river (0m, 200m, 400m and 600m) as factor A, and four (4) farmers' plots were selected based on the years of irrigation (0, 10, 20 and 30 years) as factor B while three (3) farmers plots with similar irrigation history were used as replicates, with this arrangement 12 plots were selected in each farming location giving a total of 48 plots from which soil samples were taken for analysis. The mean concentration of the parameters were pH (7.09-7.82), Electrical Conductivity {EC} (0.09-0.14), Sodium Adsorption Ration {SAR} (0.12-0.74) Exchangeable Sodium Percentage {ESP} (3.59-9.46), Sand (74.67-82.10), Silt (11.28-16.67), Clay (6.89-11.06), Mean Weight Diameter (1.38-1.53), Bulk density (1.12-1.29), Porosity (51.26-54.08), Saturated Hydraulic Conductivity (1.18-3.57). The mean concentration showed increase as the water flow downstream while higher value observed at location 3 (400m), the collected soil samples were subjected to analysis of variance using randomized complete block design (RCBD) at 5% probability level. The result showed that all the parameters were in a safe range when compared with WHO (2005) and FAO (2007) standard. It was recommended that effluent discharge and dumping of refuse along the river channel should be forcefully discouraged and that government should help in providing household disposal sites for the inhabitants of the town and that regular monitoring of Asa river be carried out as there is notable increase in the level of human and industrial activities along the course of the river.

Key words: Irrigation, Water quality, Soil structure, Asa River

Introduction

Irrigation can be described as the application of water to the soil to make available essential moisture for plant growth. It also serves as insurance against drought and to provide a cooling effect on the soil environment for plant growth and development. So, irrigation is aimed at improving and raising the productivity of soil resources. The principle, according to Handson (1999), is that the environment is characterized by fair to good soils but poor and unreliable irrigation water can cause advert effect on soil structure, soil properties as well as plant growth as it is the case in dry and semi-dry lands.

The quality of irrigation water (Salinity & Sodicity) has the potential to significantly affect soil structural properties (Levy and Miller, 1997). Saline irrigation water contains dissolved substances known as salts. In some arid and semi-arid regions, most of the salts present in irrigation water are chlorides, sulfates, carbonates, and bicarbonates of calcium, magnesium, sodium and potassium. While salinity can affect soil structure, it can also negatively affect plant growth and crop yields. Sodicity refers specifically to the amount of sodium present in the irrigation water. Irrigation with water that has excess amounts of sodium can adversely impact soil structure making it difficult for plant growth (Levy and Miller, 1997). Highly saline and sodic water qualities can cause problems for irrigation, depending on the type and amount of salts present, the soil type being irrigated, the specific plant species and growth stage, and the amount of water that is able to pass through the root zone. Under field conditions, irrigated soils are exposed to sequential periods of rapid wetting followed by drying. Soils which are subjected to these wetting and drying cycles have been found to exhibit low aggregate stability (Caron et al., 1992, Rasiah et al 1992.) resulting in the release of colloidal material and the collapse of soil pores (Levy and Miller, 1997). However, the quality of the irrigation water applied will also affect the soil chemical properties which influence soil dispersion and aggregate breakdown, surface sealing and crust formation (Schofield, 1955).

Khan et al., (2006) reported that the impact of irrigation water on soil structure seems certain to be very dependent, apart from the direct effects of rainwater alone, soil structure can be dramatically and rapidly degraded in other ways by irrigation. They also purported that the use of irrigation water of poor quality has a potential ability to inflict soil structural damage, in this regard, both adverse natural hydrology and poor irrigation water quality can independently degrade soil structure (and soil chemistry) by making the soil sodic which can also influence soil dispersion, aggregate breakdown, surface sealing and crust formation. The researchers further found that a SAR increased caused by irrigation water had an adverse impact on water infiltration, increasing sodicity and decreasing the concentration of applied water enhance physico-chemical dispersion. This dispersion, in turn, leads to a reduction in soil hydraulic conductivity.

According to Levy, (1992) and Naidu, (2003) the structural stability of soil is degraded dramatically by sodicity, a soil condition which promotes dispersion. They also recalled that the stresses that irrigation places on soil structure are amplified considerably when the irrigation water itself is of poor quality, water is a vehicle for the movement of vast amounts of salt in the landscape and irrigation has the capacity to transform a structurally stable soil into a salt-affected one. Salinity has a much more direct physical effect on soil structure as it is always due to high concentrations of sodium in irrigation water. The capacity of irrigation water to transform a non sodic soil into a sodic one depends upon a number of factors including soil type, management, and time and water quality. The water transmission capacity of any soil depends on the physical characteristics of the soil and how well it is managed. The physical characteristics are, themselves dependent on the structure or size distribution of mineral particles: on the structure or manner in which these particles are arranged: on the kinds of clay minerals present and the amount of exchangeable ions adsorbed upon them: and on the amount of organic matter incorporated with the mineral matter. In this study the characteristics of the soil are measured by various concepts such as salinity test, aggregate stability, bulk density, porosity, hydraulic conductivity among others. Good structure for crop growth depends on the presence of aggregate of soil particles 1-10mm which remain stable when wetted, such water stable aggregates will be porous so that they remain aerobic and yet possess sufficient numbers of pores to retain water for growth of plants (Tisdall and Oades, 1982). Therefore, detailed investigation regarding the effect of irrigation water quality on soil structure and its suitability for crops has no yet been done in the study area. Keeping these in mind, the present research reports the bench mark survey of irrigation water quality on soil structure Along ASA RIVER.

Objectives of the study

The main and specific objectives are:

To evaluate the effect of irrigation water on soil structure along Asa River

- To assess the effect of the use of Asa river water for irrigation on soil physico-chemical properties
- To determine long term use of Asa river water for irrigation on soil salinity
- To assess future effect of the use of Asa river for irrigation on soil and plant growth

Materials and Methods

Description of Experimental Location: A field research was conducted to evaluate the effect of irrigation water quality on soil structure along Asa rivier bank Ilorin.

Ilorin is the capital city of Kwara State. It is located by latitude 80 261N and longitude 40 301E with an area of about 100km2. The climate of Ilorin is characterized by wet and dry seasons, the rainy season normally begins at the end of March and last till November, the total annual rainfall ranges from 800 - 1,200mm in the northwest and 1,000- 1,500mm in the southeast (Oyegun, 1983). Daily temperature can be as high as 37oC just before the rainy season and as low as 21oC during harmattan (Oyegun, 1983).

According to (Eneudu, 1981) a large proportion of the land area along the river bank is dominated by Alluvial and Hydromorphic soils on the river savannah. The author also stated that a substantial area of the land is underlined by sedimentary rock, which contains both primary and secondary laterites and alluvial deposits, the soil type has both sandy and clayey deposits lying on top of each other, while the sandy deposits is characterized by low water holding capacity, which encourages infiltration, the clayey deposits beneath results in water logging during rainy season, thus encourages flood and runoff across the river bank.

The study areas covered selected portions of Asa river bank and are located at the Ilorin west local government. Asa river is the main river in Ilorin, the river flows in the South-north direction. It divides Ilorin into two parts: a western part representing the core or indigenous area and the eastern part where the Government Reservation Area (GRA) is located (Oyebanji, 1993).

Asa river is a major river of economic, agricultural and environmental significance in Ilorin—the capital city of Kwara State, Nigeria. The tributaries of Asa river in Ilorin are Agba, Aluko, Atikeke, Mitile, Odota, Okun and Osere. Adekunle (2008) and Adekola et al., (2007) observed that the river receives effluents from industries located along its course, apart from domestic wastes and other activities carried out along it that contribute to its pollution. They also reported that the major identified source of pollution of Asa river was direct runoff of effluents from the industries.

The research work was carried out at four (4) locations along Asa river bank used by farmers for dry season farming (vegetable production). The distances along the river bank corresponded with intervals in the river which serves as the farmers sources for irrigation water.

Field Studies

A total of 48 composite surface soil samples were collected from four (4) locations along the river bank at 200m distance which serve as Factor A while 10 years of history was used as Factor B for irrigation water. At each location 12 soil samples were taken from depth of 0-20cm and then bulk and stored for laboratory analysis, all samples were collected with the aid of stainless steel soil auger. Also 12 undisturbed soil core samples were taken from each location making a total of 48 core samples in all the four (4) locations. At each farming location three (3) farmers' plots with different irrigation history (0, 10, 20 and 30years irrigation duration) were selected while three (3) farmers' plots with similar irrigation history were used as replicates. With this arrangement 12 plots were selected in each farming location giving a total of 48 plots (4x4x3). All samples were collected and transported to the laboratory for the determination of physical and chemical soil quality parameters.

Laboratory Analysis

Bulked soil samples were air-dried and ground to pass through 2-mm sieve. Routine laboratory analysis was carried out to evaluate the physic-chemical properties of the soil as follows: The soil pH and EC (Electrical Conductivity) were determined in distilled water (1.2 soil/water) with a glass electrode pH meter and electrical conductivity meter. Soil particle size distribution was determined by hydrometer method (Bouyoucos, 1962) with sodium hexametaphosphate (calgon) as dispersing agent. Na was measured using flame photometer while Mg was determined by atomic absorption spectrophotometer. Ca content of the soil was determined by digestion in Nitric acid (HNO3) and perchloric acid (HClO4) in a 1:2. The Na, Mg and Ca determination were used to calculate Sodium Absorption Ratio (SAR).

Salinity Hazard Determination in the soil.

The Sodium Absorption Ratio (SAR) and Exchangeable Sodium Percentage (ESP) were used as indices of salinity hazard (U.S salinity laboratory staff, 1954). They were calculated thus:

$$SAR = \frac{Na^+}{\sqrt{(Ca+Mg)^{++}/2}}$$

ESP = Exchangeable {(Na)/ (Ca + Mg + K + Na)} x 100

Bulk density was analyzed using core method as proposed by Blake and Hartge (1986) while porosity was calculated from bulk density data assuming a particle density of 2.659gm-3, hydraulic conductivity and aggregate stability were determined according to the methods of Dane and Topp (2002).

Data analysis.

Data collected for soil sample were subjected to Analysis of Variance (ANOVA) using Genstat Discovery (Edition 4) statistical package and significant means were separated using the least significant difference (LSD) at 5% probability level.

Results and Discussion

Effect of distance of water and years of application on soil pH

Table 1 indicate that irrigation duration and the distance between points from which irrigation water was sourced had significant ($p<0.05$) effects on the mean soil pH value in the treated soils. The data obtained generally showed that the mean soil pH value increased significantly ($p<0.05$) for every 200m increase in distance between irrigation water sources up to location three (400m downstream) with the lowest value (7.09) observed in location one (control) whereas the highest value (7.82) was observed in location three. There was a decrease in the mean soil pH value in location four (600m downstream). The significant increase observed at location two and three could be contribution of soluble salt from irrigation water. This agreed with the observation of (Schofield, 1955) who reported that increase soil pH could be contribution of soluble salt from irrigation water. While the decreased observed at location four could be as a result of dilution.

The mean effect of irrigation duration on soil pH value showed that soil pH increased significantly over intervals of 10years. The highest pH value of 7.58 was observed following 30years of the use of Asa river water for irrigation while the lowest 7.30 was observed on newly established farms without history of prior use of Asa river water for irrigation. The increased observed at 30years could be due to long term use of irrigation and continuous land cultivation. Comparing the value observed for pH in the soil, it fell within the permissible limits (6.5 – 8.5) by FAO (2007). However there is high tendency of the cultivated soil becoming alkaline as a result of intensive agriculture going on from year to year. Thus at high pH the concentration of heavy metals could reduce due to their insolubility, heavy metals has been found to be highly reduce at high pH as reported by McBride, (1994).

Table 1. *Effects of distance of water and years of application on soil pH.*

distance of Water (m) Factor A	Years of application (years) Factor B				Mean
	0	**10**	**20**	**30**	
0	7.01	7.05	7.14	7.19	7.09
200	7.02	7.07	7.17	7.20	7.21
400	7.67	7.80	7.83	7.97	7.82
600	7.24	7.30	7.50	7.70	7.44
Mean	7.30	7.33	7.38	7.58	

$LSD_{0.05}$, Factor A= 0.036, Factor B = 0.038, AXB = 0.182

Effect of distance of water and years of application on electrical conductivity (EC) in the soil.

Table 2 shows mean of EC values in soils treated with irrigation water from selected points along Asa river under various irrigation duration. The data obtained showed that the mean EC values increased significantly ($p<0.05$) for every 200m increase in distance between irrigation water sources up to location three (400m downstream). The lowest value 0.09 dsm^{-1} was observed in location one (control) while the highest value, 0.14 dsm^{-1} was observed in location three. However, there was a decreased in the mean soil EC (0.12) in location four (600 downstream). The significant increase observed at location two and three could be as a result of proximity of these locations to the source of pollutant and the salt content from irrigation water, this is in agreement with the findings of Ayers and Westcot (1976). The mean effect of irrigation duration on soil EC values showed that soil EC values increased significantly over intervals of 10years. The highest concentration of 0.16dsm^{-1} EC in the soil was observed following 30years of the use of Asa river water for irrigation while the lowest 0.08 dsm^{-1} was observed on newly established farms without any history prior to the use of Asa river water for irrigation; this could be due to salt accumulation in the soil from irrigation water. The result of this analysis showed that the EC of the soil samples were found below the degree of restriction of uses (<0.7-3.0dsm^{-1}) Oster and Schroer (1979). However; if these areas are continuously cultivated and irrigated with this river water, it could increase soil salinity as well as sodicity and high EC value indicate that the osmotic pressure of the soil solution will increase which will affect plant yield by decreasing the water uptake and soil water availability (Provenzano, 2007).

Table 2. *Effects of distance of water and years of application on electrical conductivity (dsm^{-1}) in the soil.*

Distance of Water(m)Factor A	Years of application (years) Factor B				Mean
	0	10	20	30	
0	0.06	0.09	0.11	0.13	0.09
200	0.08	0.10	0.12	0.14	0.11
400	0.10	0.14	0.15	0.18	0.14
600	0.09	0.11	0.14	0.17	0.12
Mean	0.083	0.11	0.13	0.16	

$LSD_{0.05}$, Factor A= 0.012, B = 0.014, AXB = 0.016

Effect of distance of water and years of application on sodium adsorption ratio (SAR) in the soil.

Table 3 shows mean SAR in soils treated with irrigation water from selected points along Asa river under various irrigation duration. The data obtained showed that the mean SAR increased significantly ($p<0.05$) for every 200m increase in distance between irrigation water sources up to location three (400m downstream). The lowest value of 0.12 was observed in location one (control) while the highest value of 0.74 (slight to moderate) was observed in location three. Thus, there was a decrease in the mean SAR in location four (600m downstream). The significant increase observed at location two and three could be contribution of salt content from irrigation water as a result of effluent discharge into the river used for irrigation. The decreased observed at location four could be as a result of leaching and or dilution the result shows none and or no harm to the soil Oster and Schroer (1979),

The mean effect of irrigation duration on the SAR of treated soil showed significant increase over intervals of 10years. According to the result of the analyzed soil sampled the highest value of 0.63 was observed following 30 years of the use of Asa river water for irrigation while the lowest value of 0.09 was observed on newly established farms without history prior to the use of Asa river water for irrigation. The result obtained could be attributed to the accumulation of salt in the soil as a result of long term use of irrigation water. This finding was also reported by (Hedeyasu, 2006). Moreover, the mean SAR of the soil sampled were found below (>3.0) FAO (1994), this implies that the river water is not saline and is not hazardous to soil for irrigation. SAR is an indication of salinity of the soil.

Table 3. *Effects of distance of water and years of application on SAR in the soil.*

distance of Water (m)Factor A	**Years of application (years)Factor B**				**Mean**
	0	**10**	**20**	**30**	
0	0.06	0.10	0.14	0.16	0.12
200	0.08	0.12	0.44	0.65	0.32
400	0.10	0.90	0.95	0.99	0.74
600	0.14	0.66	0.68	0.70	0.55
Mean	0.09	0.45	0.55	0.63	

$LSD_{0.05}$, Factor A = 0.021, B = 0.020. AXB = 0.031

Effect of distance of water and years of application on exchangeable sodium percentage (ESP) in the soil

The source of irrigation water along Asa river course and duration of irrigation was observed to significantly ($p<0.05$) increase the exchangeable sodium percentage (ESP) of treated soils (Table 4). The data obtained showed that mean treated values of ESP increased significantly ($p<0.05$) for every 200m increase in distance between irrigation water sources up to location three (400m downstream) with the lowest value (3.59%) observed in location one (control) whereas the highest value (10.15%) was observed in location four. The significant increase observed at location two, three and four could be traced to the dissolve salt from irrigation water, as a result of contaminated water from different sources that drained into Asa river such as sewage sludge, kitchen waste and effluent from companies.

The mean effects of irrigation duration on ESP significantly increase over intervals of 10years. The highest ESP value of 10.71% was observed following 30years of the use of Asa River water for irrigation while the lowest 3.94% was observed on newly established farms without history of prior use of Asa river water for irrigation. This indicates accumulation of salt (sodium) due to long term use of Asa river for irrigation, similar result was observed by (Hedeyasu, 2006). The result obtained fell below the critical limit by Reev *et al*, (1954) and Majid, (2009), who reported that when the ESP in the soil is 15%, then the soil is sodic. This implies that the soil is free from sodicity (excess sodium). Similar result was observed by Sharinberg, (1994).

Generally the use of Asa River water in location three (400m downstream) for 30years showed the highest significant increase (13.60%) in the soil ESP concentration. This could be as a result of long term use of irrigation water

Table 4. *Effects of distance of water and years of application on ESP % soil.*

distance of Water (m)Factor A	Years of application (years)Factor B				Mean
	0	10	20	30	
0	2.01	2.80	4.70	4.83	3.59
200	2.07	3.40	11.83	12.60	7.48
400	3.23	8.80	12.20	13.60	9.46
600	8.45	10.10	10.23	11.80	10.15
Mean	3.94	6.28	9.74	10.71	

$LSD_{0.05,}$
Factor A = 0.220
Factor B = 0.091
AXB = 0.320

Effect of distance of water and years of application on soil particle analysis in the soil

Table 5-7 indicate that irrigation duration and the distance between points from which irrigation water was sourced had significant ($p<0.05$) effects on the mean sand in the treated soils. The data obtained showed That the mean of sand, silt and clay increased significantly ($p<0.05$) for every 200m increase in distance between irrigation water sources up to location three (400m downstream) with the lowest value (74.67%) for sand, (11.28%) for silt and (6.89%) for clay were observed in location one (control),whereas the highest value (84.91%) for sand, (19.86%) for silt and (11.06%) for clay was observed in location four.

The average values of percentage sand silt and clay reveals a loamy sand and sandy loamy texture in all the experimental locations. The loamy sand texture was found from 0m (control) till 200m distance at 20 years of irrigation. Consequently; the percentage sand content of the soil has the highest value of 86.24% at 10 years of irrigation while clay content of the soil has 5.71% lowest value at 30 years of irrigation following 0m (control).

Table 5. *Effects of Distance of water and years of application on sand (%) in the soil.*

Distance of water (m)	Years of application (years)				Mean
	0	10	20	30	
0	78.45	73.91	75.40	70.24	74.67
200	75.65	86.24	85.91	72.57	80.09
400	72.34	87.91	71.91	83.24	82.10
600	74.24	80.57	79.24	82.24	81.91
Means	74.17	76.91	72.62	77.07	

LSD0.05, Factor A=2.04, Factor, B=2.67, AXB = 3.35

The textural classes were mainly loamy sand at the two locations, this could be the appropriate soil surface or the required topsoil for plant growth which agrees with the findings of Nwa and Ogunase (1983) who reported that loamy sand was suggested as the soil surface layer otherwise, disperse or breakdown by chemical or tillage forces, except at 30years of location two (200m) which had textural class of sandy loam which could be traced to the dispersing fraction of the soil as a result of high sodium content and or breakdown of soil structure as a result of poor irrigation water, this was the same at location three (400m) and location four (600m).

Table 6. *Effects of Distance of water and years of application on silt (%) soil.*

Distance of water (m)	Years of application (years)				Mean
	0	10	20	30	
0	11.65	15.70	13.85	14.50	11.28
200	14.75	17.67	17.00	17.00	13.40
400	15.00	19.67	20.70	21.20	16.67
600	13.25	17.00	23.67	23.33	19.86
Means	14.38	14.34	16.92	15.58	

LSD0.05, Factor A=2.61, Factor B=2.49, AXB = 2.98

Table 7. *Effects of Distance of water and years of application on clay (%) soil.*

Distance of water (m)	Years of application (years)				Mean
	0	10	20	30	
0	8.95	7.43	6.44	4.76	6.89
200	9.85	8.08	7.09	10.43	8.61
400	12.66	11.41	12.09	7.76	10.98
600	11.08	9.09	14.31	9.76	11.06
Means	9.18	8.75	11.44	8.78	

LSD0.05, Factor A=1.22, Factor B=1.03, AXB = 2.06

Table 8. *Particle sizes showing the textural class of the soils.*

Location (m)	Samples (years)	Sand %	Silt %	Clay %	Textured Class
	10	80.24	12	7.76	LS
0	20	78.00	15	6.76	LS
	30	82.24	12	5.76	LS
	10	86.24	6.7	7.0	LS
200	20	85.41	7	7.0	LS
	30	72.8	17	10.7	SL
	10	66.7	21.7	11.41	SL
400	20	66.7	21	12.1	SL
	30	66.6	21.6	11.8	SL
	10	73.7	17	9.0	SL
600	20	65.24	23.7	11.1	SL
	30	70.24	23.1	9.76	SL

LS = Loamy sand SL = Sandy loam

Effect of distance of water and years of application on mean weight diameter (MWD) in the soil

Table 9 indicate that irrigation duration and the distance between points from which irrigation water was sourced had significant ($p<0.05$) effects on the mean weight diameter. The data obtained showed that effect of change in distance between water sources on mean weight diameter (MWD) of soil aggregate increased significantly ($p<0.05$) at location one and four but decreased in location two and three respectively. The decrease observed in location two and three could be attributed to the accumulation of sodium salts contained in the irrigation water over time in the soil causing dispersion of soil aggregates.

The mean effect of irrigation duration on mean weight diameter (MWD) of soil aggregates showed decrease over intervals of 10years. The highest mean of 1.56mm was observed on newly established farm (0year) without history of prior use of Asa river water for irrigation while the lowest 1.33mm was observed at 30years, the significant increased observed at 0year could be attributed to the fact that the soil has not been disturbed with constant irrigation and cultivation making the aggregate of soil particles remain stable when wetted given the soil a larger pores for favorable aeration and good drainage as well as good stability than others before the commencement of irrigation application and farming activity , while the lowest value observed at 30years could be impact of salt content from irrigation water leading to little dispersion and structure deteriorated in the soil, Ayers and Westcot, (1976) reported that all irrigation water contains dissolved mineral salts weather big or small. Also the reduction observed at 30years of irrigation duration could be as a result of constant land cultivation leading to the breakdown of soil aggregate stability. However the mean weight diameter of the study soil was under good structure for crop growth when compared with the finding of Tisdall and Oades, (1982) who reported that aggregate of soil particles between 1- 10mm diameter remain stable when wetted, thus providing good structure for crop growth.

Table 9. *Effects of distance of water and years of application on mean weight diameter (mm) in the soil.*

distance of Water (m)Factor A	Years of application (years)Factor B				
	0	**10**	**20**	**30**	**Mean**
0	1.53	1.56	1.52	1.51	1.53
200	1.55	1.50	1.26	1.20	1.39
400	1.57	1.43	1.36	1.30	1.38
600	1.59	1.54	1.40	1.29	1.42
Mean	1.56	1.45	1.37	1.33	

$LSD_{0.05}$, Factor A = 0.166, B = 0.06, AXB = 0.129

Effect of distance of water and years of application on soil bulk density

The source of irrigation water along Asa river course and duration of irrigation was observed to significantly ($p<0.05$) increase the bulk density of the soils (Table 10). The data obtained showed that mean bulk density value increased significantly ($p<0.05$) for every 200m increase in distance between irrigation water sources with the lowest value (1.12g/cm^3) observed in location one (control) whereas the highest value (1.29g/cm^3) was observed in location four.

The mean effect of irrigation duration on soil bulk density showed significant increase over intervals of 10years. The highest bulk density value of 1.35g/cm^3 bulk density in the soil was observed following 30years of the use of Asa river water for irrigation while the lowest value of 0.99g/cm^3 was observed on newly established farms without history of prior use of Asa river water for irrigation. The highest value observed at 30years of irrigation could be attributed to continuous cultivation; this agreed with the finding of Adeoye, (1983) who reported that continuous land cultivation could increase bulk density. However the result observed showed that the bulk density is in safe range when compared with the standard given by Grossman *et al*, (2002) who stated that bulk density >1.6 g/cm^3 is not safe and at the level of compaction.

Table 10. *Effects of distance of water and years of application on soil bulk density (g/cm^3)*

distance of Water (m)Factor A	Years of application (years) Factor B				
	0	**10**	**20**	**30**	**Mean**
0	0.9	1.03	1.27	1.30	1.12
200	1.00	1.23	1.32	1.34	1.22
400	1.02	1.33	1.38	1.37	1.27
600	1.03	1.20	1.24	1.40	1.29
Mean	0.99	1.19	1.30	1.35	

LSD $_{0.05}$, Factor A = 0.04, B = 0.02, AXB = 0.064

Effect of distance of water and years of application on soil porosity

Table 11 indicate that irrigation duration and the distance between points from which irrigation water was sourced had significant (p<0.05) effects on soil porosity. The data obtained showed that soil porosity increased significantly (p<0.05) at interval of 200m respectively. The lowest value of (51.26%) was observed in location one whereas the highest value (54.08%) was observed in location four.

Table 11. ***Effects of distance of water and years of application on soil porosity (%)***

distance of Water (m)Factor A	Years of application (years)Factor B				
	0	**10**	**20**	**30**	**Mean**
0	50.04	52.14	52.40	54.47	51.26
200	51.12	54.90	51.44	52.62	52.52
400	52.14	53.60	50.14	50.53	53.60
600	54.14	51.54	51.20	56.44	54.08
Mean	50.86	52.26	53.29	54.26	

LSD $_{0.05}$, Factor A = 2.028, B = 2.144, AXB = 3.021

The mean effect of irrigation duration on soil porosity concentration showed increase over intervals of 10years. The highest total porosity of 54.26% was observed following 30years of irrigation water while the lowest 50.86% was observed on newly established farm 0year, the significant increase observed at 30years of irrigation could be due to activities of micro-organisms which open the top soil or broken-down of soil particles as a result of continuous cultivation over time. Thus the total porosity is in control when compare with the report of Oliver (1997) that the total porosity is low below 45%.

Saturated hydraulic conductivity (Ks)

Table 12 revealed the result of Ks .The data obtained showed that Ks increased significantly ($p<0.05$) at interval of 200m respectively. The lowest value of (1.18 cmh^{-1}) was observed in location one whereas the highest value (3.57cmh^{-1}) was observed in location four.

The mean effect of irrigation duration on Ks showed that Ks increase over intervals of 10years. The highest Ks 3.20 cmh^{-1} was observed at 30years while the lowest 2.16 cmh^{-1} was observed at 0year, the highest Ks obtained at 30years could be due to cultivation which encourage the activity of micro-organisms Nwa and Ogunase (1983).

Table 12. *Effects of distance of water and years of application on saturated hydraulic conductivity (cmh^{-1}) in soil*

Source of Water (m)Factor A	Irrigation Duration (years)Factor B				Mean
	0	**10**	**20**	**30**	
0	1.03	1.01	1.33	1.35	1.18
200	2.06	3.33	2.36	3.70	2.86
400	2.85	3.47	3.57	3.80	3.42
600	2.70	3.75	3.87	3.97	3.57
Mean	2.16	2.62	2.78	3.20	

$LSD_{0.05}$, Factor A = 0.184, Factor B = 0.151, AXB = 0.24

Conclusion

Asa river supplies the basic water needs of Ilorin and its environs after treatment at Asa Dam treatment plant. Shortage of sufficient potable water has led many people to depend on this river not only for drinking but also, for other domestic, agricultural and industrial uses, therefore, its quality and pollution status is thus of serious concerns that worth investigation and assessment.

The sources of pollution identified above causes the pollution of Asa river as reported by different authors, but no research work has been done on the effect of the river water use for irrigation on soil structure. This brought out the need to assess the quality of Asa river for irrigation. Parameters such as EC, pH, SAR, and ESP were investigated in the soil as physic-chemical properties while physical properties such as Aggregate stability, Bulk density, Total porosity and saturated hydraulic conductivity were also investigated from which all the parameters were found in safe range as approved by FAO (1989) and WHO (1996, 2005), the collected soil samples were subjected to analysis of variance using randomized complete block design (RCBD).

The sodium concentration in soil for EC, SAR and ESP were found below standard as approved by different agencies, as well as the physical parameters. This shows that, the condition of soil structure across the river bank is in a good state and is therefore good for dry season irrigation farming. However there is high tendency of the cultivated soil along the river bank becoming alkaline and or sodic/saline as a result of intensive agriculture through application of irrigation water for moisture content going on from year to year. But proper treatment of effluent discharge into the river should be done by each company before released into the river as long term accumulation of these chemical and or heavy metals could pose a potential treat to soil health.

It is therefore recommended that effluent discharge and dumping of refuse along the river channel should be forcefully discouraged and that government should help in providing household disposal sites for the inhabitants of the town and that regular monitoring of Asa river be carried out as there is notable increase in the level of human and industrial activities along the course of the river. Finally it is also recommended to coordinate different efforts at the level of the community dwellers and the government to rescue the downstream of Asa river from the current hazard- posing environmental problems.

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