PROCEEDINGS OF THE 46TH ANNUAL CONFERENCE OF THE SOIL SCIENCE SOCIETY OF NIGERIA, MARCH 14TH-18TH, 2022

DEPARTMENT OF SOIL SCIENCE,
FACULTY OF AGRICULTURE,
INSTITUTE FOR AGRICULTURAL RESEARCH, SAMARU,
AHMADU BELLO UNIVERSITY ZARIA.

THEME: SUSTAINING LIVING SOIL ECOSYSTEM THROUGH ADOPTION OF SOIL MANAGEMENT PRACTICES FOR MITIGATING CLIMATE CHANGE FOR NATIONAL DEVELOPMENT

EDITORS
J. H. ABDULKAREEM
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THEME: Sustaining Soil Ecosystem through Adoption of Soil Management Practices for Mitigating Climate Change for National Development

AHMADU BELLO UNIVERSITY, ZARIA, KADUNA STATE

MARCH 14TH – 18TH 2022

EDITED

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FORWARD

The 46th Annual Conference of Soil Science Society of Nigeria (SSSN) was held at the Professor Balarabe Tanimu Conference Hall of the Institute for Agricultural Research (IAR), Ahmadu Bello University, Zaria. The conference was scheduled to last from MARCH 14TH TO MARCH 18TH 2022 with the theme SUSTAINING LIVING SOIL ECOSYSTEM THROUGH ADOPTION OF SOIL MANAGEMENT PRACTICES FOR CLIMATE CHANGE FOR NATIONAL DEVELOPMENT. The conference was attended by over 150 registered Soil Scientists, farmers and other stakeholders. Over 120 papers were presented in parallel sessions, out of which 61 papers presented were selected, peer reviewed and published in the Book of Proceedings.

Prominent constraints to sustainable food crop production in the Nigeria ecologies include soil water deficits, nutrient deficiencies, climate change and degradation of soil and its resources. These constraints were discussed exhaustively and appropriate management practices proffered as applicable in respective ecologies in Nigeria. This enabled participants to have firsthand view of climate change events and mitigation practices, as well as suitable climate-smart agriculture, soil and water management and nutrient management practices to boost sustainable food crop production and environmental conservation in Nigeria. Issues regarding soil management under irrigated food crop production schemes were also discussed and solutions proffered.

The sub themes for which papers were presented addressed various areas of Soil Science. The sub themes are:

1. Pedology and Land use Management
2. Soil Chemistry and Fertility
3. Soil Phyics, Soil Conservation, Agroclimatlogy, Climate Smart Agriculture, Soil and Water Management
4. Soil Microbiology and Pollution Control
5. Extension in Soil Science

The growing awareness of effects of climate change and global warming in the Nigerian environment presented a new vista of broad scientific interaction that embraced and not limited to Soil Science, but opened discussion across and among fields; such as Geography, Engineering, Environment, Urban and Regional, Farmers and other stakeholders. Government and Non-Governmental. agencies, Extension, Marketing agents and credit organizations present; in particular, applauded outcome of these sessions as they promise to provide policy direction for a sustainable food production in Nigeria and was captured in the communiqué. It is my unwavering belief that you will find information contained in this book very timely and useful.

Professor ODUNZE Azubuike Chidowe
Chairman LOC

January, 2023

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The editors wish to express their profound gratitude and appreciation to the Vice Chancellor, Ahmadu Bello University, Zaria; Professor Kabir Bala and the Executive Director, Institute for Agricultural Research, Ahmadu Bello University, Zaria,; Professor Mohammed Faguyi Ishiyaku for hosting the 46th Annual Conference of Soil Science Society of Nigeria and providing participants with ambient environment and facilities for the conference. We are particularly grateful to the Executive Directors of the Institute for Agricultural Research (IAR) Prof. Mohammed Faguyi Ishiyaku, National Agricultural Extension Research and Liaison Services (NAERLS); Prof. E.I. Ikani, and the Division of Agricultural Colleges (DAC), Ahmadu Bello University, Zaria; Prof. Musa Mahadi, for the financial support from their organizations towards the conference, as well as their facilities for hosting the conference. We indeed appreciate your partnership as co-hosts to this conference. We are also immensely indebted to the Dean Faculty of Agriculture, Ahmadu Bello University; Prof. Mukhtari Mahmud for the various contributions towards a successful hosting of the 46th Annual Soil Science Conference as a co-host.

We wish to thank immensely all the Academic Staff of the Department of Soil Science, Ahmadu Bello University for their magnanimous financial contribution towards the success of this conference. Our appreciations also goes to the Chairmen and members of the various sub-committees of the Local Organizing Committee (LOC) for their co-operation that resulted in a job well done at the conference hosting. Patience, hard work, diligence, meticulous planning and personal sacrifice made this 46th Annual Soil Science Conference successful despite the Academic Staff of University Union's (ASUU) industrial action that partially interrupted proceedings at the conference.

The Chairman acknowledges gracefully the financial contributions from many individual and corporate donors listed in this book of proceedings, without which, successful hosting of this conference could have been difficult to attain. We appreciate your financial contributions.

We thank all who reviewed the manuscripts for job well done. The list of reviewer is also contained in the book in appreciation.

We appreciate very much the moral and financial supports from the Federal Ministry of Agriculture and Rural Development (FMARD) and the Agricultural Research Council of Nigeria (ARCN). Your fatherly roles in mentoring the Soil Science Society of Nigeria towards attaining and maintaining relevance in policy articulation for sustainable agriculture, soil management and environmental conservation at both national and global forum is immensely appreciated.

The Editors
January, 2023

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Tolerance of *nitrosomonas spp* to carbofuran and cyhalothrin pesticides in the soil of teaching and research farm Gidan Kwano Minna, Niger State.

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Abstract

The tolerance of Nitrosomonas spp to Carbofuran and Cyahalothrin Pesticides was investigated by collecting soil samples from a portion of the Teaching and Research farm of the Federal University of Technology, Minna. The soil collected was taken to the Soil Science and Land Management Microbiology laboratory and subjected to toxicity testing for a period of 21 days, at room temperature. Pesticide concentration of 0.00, 3.125, 6.25, 12.5, 25 and 50% were prepared by transferring 0.00, 3.125, 6.25, 12.5, 25 and 50ml of stock solution into 100, 96.8, 93, 75, 87.5, 75 and 50ml of sterile distilled water respectively. Part of the soil collected was sterilized at 121oC for 15minutes with the autoclave followed by the filling of the pots with 1.5 kg of sterilized soil, and watering before inoculating with 10mls of Nitrosomonas spp per pot and incubating for 1, 7, 14 and 21 days at 28oC. From the treated pots and at every incubation interval, 1g of soil was taken and diluted serially to achieve 10-3 dilution level. From 10-3dilution, 1ml was plated and incubated for 4 days at 28oC. Result obtained were interpreted using pollution/toxicity biomonitoring evaluation chart and it indicated that logarithm mortality of Nitrosomonas spp increased with increase in the toxicant concentration and exposure time to cyahalothrin pesticide while decrease in Nitrosomonas popultion was observed with increased toxicant concentration and exposure time to carbofuran pesticide. The median lethal concentration (LC50) of cyahalothrin pesticide on Nitrosomonas spp was 100% indicating that effect of cyahalothrin on Nitrosomonas spp was mild. Conversely, the median lethal concentration (LC50) of carbofuran pesticide on Nitrosomonas spp was 16% implying that its effect on Nitrosomonas spp was toxic

Keywords: carbofuran; concentration; lethal; nitrosomonas; pesticides.

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1.0 Introduction

Pesticides application contributes greatly to the pollution of the environment. These chemicals are intentionally introduced into the soil environment to control pests, as part of agricultural practices. Large scale application of these pesticides leads to land pollutions, pesticides leaching into ground water, surface run-off to nearest water bodies, disseminations by wind and soil erosion, which to a great extent contributes to the dispersal of these chemicals in the environment far from the source of application (Obire and Owaji-Eli, 2014). This results in the death of wildlife while some suffer damage to vital functions such as reproductive failure (Johnsen *et al.*, 2001). The applications of pesticides for the control of pest and their activities in the soil have become an issue of concern, since these chemicals are persistent in the environment, could enter food chain, producing devastating effects, as its effect is evident in the environment (Obire and Owaji-Eli, 2014).

Toxicity of substances to microorganisms may be viewed through growth inhibition, enzyme activity,oxygen consumption, ATP level and colonies formed on agar plates (Oranusi and Ogugbue, 2002). Use of *Nitrobacter spp* and *Nitrosomonas spp* as a tool for bioassay was proposed by Williamson and Johnson (1981), where they described the method for the bioassay as simple and the resultssensitive. These organisms are chemoautotrophs and derive their chemical energy from the oxidative electron transport chain. These groups of organisms play a very important role in nitrogen removal process especially in wastewater treatment plant, in nitrogen cycle and the overall fertility of the soil and water environment. When it comes to bioassay, microorganisms especially bacteria are the organisms of choice due to their short life cycle, small space required for culturing, ease of handling and lower cost (Wang and Reed 1983; Williamson and Nelson, 1983). *Nitrobacter* and *Nitrosomona s*spp were selected as the test organisms for toxicity testing because they exhibit sensitivity to most toxicants higher than other heterotrophic organisms (Williams and Reeds, 1993). Nitrogen is converted to nitrite after the ammonification process by *Nitrosomonas spp* which is then oxidized to nitrate by *Nitrobacter spp*. Toxic substances or waste in the environment could alter this process of nitrogen removal by the organisms. This study was therefore aimed at evaluating the toxicity and tolerance levels of carbofuran and cyhalothrin on the population of *Nitrosomonas spp* indigenous to the soil of Teaching and Research farm Gidan Kwano Minna, Niger State.

The objectives are to: determine the percentage log survival and the percentage log mortality of *Nitrosomonas spp* receiving varying concentrations of Carbofuran and Cyhalothrin pesticides and derive the median lethal concentration of Carbofuran and Cyhalothrin pesticides that affect the population of *Nitrosomonas spp*.

2.0 Materials and Methods

2.1 Study Area

The study was carried out at Teaching and Research Farm of Federal University of Technology, Minna, Niger state which is located on latitude 9°31'6"N to 9°31'50"N and Longitudes 6°26'26"E to 6°27'6"E with an estimated land mass of 10,000 hectares. Minna is located in the Southern Guinea savannah, having a sub-humid climatic condition. The mean annual rainfall is 1284mm and dry season which lasts for five (5) months occur from November to March (*Ojanuga, 2006*)

2.2 Soil Sampling and Analysis

Soil samples was collected randomly from University Teaching and Research Farm of Federal University of Technology Minna, Niger state with sterile soil auger at 0-15cm soil depth in a sterile polyethene bag and transported to the laboratory immediately. Thereafter 10g of fresh soil was refrigerated in preparation for *Nitrosomonas spp* study while 120 g of the air-dried and 2mm-sieved soil was kept for physical and chemical properties determination according to standard methods described by ISCRIC/FAO.

2.3 Physical and Chemical Properties

2.3.1 Determination of particle size distribution

The particle size of the soil was determined by Bouyoucos Hydrometer method. 50g of air dried 2mm sieved soil was weighed into sampling bottles and 100ml of 5% sodium hexametaphosphate popularly called calgon solution was added. The solution was put into a mechanical shaker and allowed to shake for 15 minutes. After which the suspension was transferred into 1L mark measuring cylinder and made up to mark with distilled water. A plunger was used to stir the soil and hydrometer readings were taken at 40sec by inserting the hydrometer into the cylinder. A thermometer was inserted, and the reading was also taken after which the soil suspension was left undisturbed for 2 hours then both the thermometer and hydrometer reading was taken at 2 hours.

2.3.2 pH determination

Ten grams of air-dry 2mm-sieved soil was weighed into beakers followed by the addition of 50 ml distilled water, then stirring for 1 minute and left to stand for 15 minutes. Thereafter, content was stirred again for 1 min and left for 15 minutes. While waiting for the last 15 minutes, the pH meter was standardized using buffer 7 solution. After that, pH meter electrode was inserted into the supernatant liquid and the reading was taken.

2.3.3 Total Nitrogen determination

Soil Nitrogen was determined using micro-kjeldahl method outlined by IITA (1989). One gram of air dried 0.5mm sieved soil was weighed into a digestion flask. Five grams of catalyst mixture and 20ml of concentrated H_2SO_4 was added and digested at 360°C for two hours until a clear digest was obtained. Twenty five millilitres of distilled water was slowly added and the flask was swirled to mix well and bring every material into suspension. Water was then added to 50ml mark, 10 ml of H_3BO_3 indicator solution into a 100ml conical flask, then 10ml of aliquot solution was transferred into a preheated distillation apparatus. Ten millilitres of 40% NaOH was added through the funnel of the distillation apparatus and distilled. When the distillate reached 35ml mark on the flask, the stem of the bypass tube was opened and the end of the condenser was rinsed with distilled water and titrated with 0.01N HCl or 0.01N H_2SO_4 using a micro-burette.

$$\%\text{Total N} = \frac{T1\text{-}T2 \times N \times V1 \times 100}{1000 \times W \times V2}$$

Where
T1= Titre value for sample
T2= Titre value for blank
N= Normality of the acid (HCl or H_2SO_4)
W= Weight of soil sample
V1= Final volume of the digestion
V2= Volume of digest taken, or aliquot used for digestion.

2.3. 4 Nitrosomonas study

Winogradsky Agar medium composition as modified by Williams and Ogolo, (2018), was weighed as follows: Agar Agar 15.0g, $FeSO4.7H_2O$ 0.4g, NaCl 2.0g, K_2HPO_4 1.0g, $MgSO_4.7H_2O$ 0.5g, and $(NH_4)_2SO_4$ 2.0g. Thereafter, 1000ml of distilled water was added prior to autoclaving at 121°C for 15 minutes at 15psi. The warm prepared medium was then poured into sterile Petri- dishes containing 1ml of 10^{-3} soil dilution that was prepared as follows: One gram (1g) of the soil was mixed into 9ml of sterile distilled water and serial diluted 10-fold to obtain 10^{-3} dilution. The 1ml aliquot from 10^{-3} soil dilution was then mixed with Winogradsky agar, by gently swirling before incubating aerobically for 3 to 4 days at room temperature (30±2°C), to obtain a grayish, mucoid, gram negative flat colonies, indicating *Nitrosomonas spp* (Winogradsky, 1890, 1892) .

2.3.5 Preparation of stock pesticides

The pesticides used were gotten from Brains and Strength Company limited at Kure Market Minna, Niger State and their stock solutions were prepared as follows:

2.3.6 Preparation of Carbofuran Stock Pesticides

The stock pesticide was prepared based on manufacturer's instruction (500g of pesticides into 100 liters of water). It was prepared, by addition of 5g, into 1litre of distilled water.

2.3.7 Preparation of Cyhalothrin Stock Pesticides

The stock pesticide was prepared based on the manufacturer's instruction (800ml of pesticides into 100 liters of water). It was prepared, with 8ml of the pesticides transferred into 1litre of distilled water.

2.3.8 *Preparation of arbofuran and cyahalothrin concentrations*

The pesticides were prepared aseptically by transferring; 3.125ml, 6.25ml, 12.5ml, 25ml, and 50ml of the different pesticides stock solution, into 96.8ml, 93.75ml, 87.5ml, 75ml, 50ml, of sterile distilled water, respectively, to obtain 3.125%, 6.25%, 12.5%, 25% and 50% concentration with 0% on the control.

2.3.9 Toxicity and tolerance test

The toxicity test procedures were done by using 12 sterile polythene pots containing 1.5kg of autoclaved soil and 10ml of *Nitrosomonas spp* added to each pot and pesticides added at different concentrations into designated pots that was labeled accordingly. Thereafter, the first culturing of *Nitrosomonas spp* after one day of treatment commenced by serially diluting the soil according to treatments and plating as earlier described. Note that the toxicity monitoring was done on days: 1, 7, 14 and 21, respectively, and plates were incubated for 3 to 4 days at room temperature (30±2^{0}C). While tolerance level was monitored by counting *Nitrosomonas* population of treated soils using the total viable count (TVC) as an index. (Williams and Dilosi, 2018).

2.3.10 Toxicity test of nitrosomonas spp receiving pesticides

The percentage log survival of the bacteria isolates *Nitrosomonas species* in the soil was calculated by obtaining the log of the counts in toxicant concentration, divided by the log of the counts in the zero toxicant concentration and multiplied by 100 (Douglas *et al.*, 2018).

i.e.: Percentage (%) log survival =Log C ÷ 100 Log c Where Log C = Logarithm count in each toxicant concentration, l
og c = Logarithm count in the control (zero toxicant concentration). Percentage (%) log mortality =100 - % log survival.

Mean of % mortality $= \frac{\Sigma \%mortality}{no\ of\ observation}$,

Medianlethalconcentration(LC_{50})=LC_{100}-$\frac{\Sigma(concentration\ difference \times \Sigma \%mortality)}{\%control}$

2.3.11 Bio-monitoring evaluation

LC_{50} Values obtained was compared to LC_{50} ranges in the pollution/toxicity bio-monitoring evaluation chart to determine extent and significance of pollution.

3.0 Results and Discussion

Table 1 shows that the textural class of the soil used in the experiment was sandy loam with the particle size distribution of clay, silt and sand as 6.64g/kg, 7.00g/kg and 86.36g/kg respectively. The soil also had a pH of 6.89 that shows a neutral soil reaction. The total nitrogen was 2.1g/kg which was moderately high.

Population of Nitrosomonas *spp* as affected by Cyhalothrin is shown in Table 2. Results showed that the highest population of 3.52 x 10^5 cfu g^{-1} was recorded at 50% concentration of cyhalothrin incubated for 21 days. Population of *Nitrosomonas spp* did not change between 7 to 14 days of incubation when no Cyhalothrin was added to the soil. A similar trend was observed between 1 to 7 days of incubation when 12.5% concentration of Cyhalothrin was added. Population of *Nitrosomonas spp* did not also change between soils receiving 12.5% and 25% concentration of Cyhalothrin respectively and incubated for 21 days. Averagely, regardless of days of incubation, population of *Nitrosomonas spp* increased with increase in concentration of cyhalothrin. Increase in population was more obvious between the 14th day and 21st day of incubation represnting 39-401% and 8 - 52% increases respectively.

Table 3 shows the population of *Nitrosomonas* spp as affected by carbofuran. Results showed that the highest population of 16.8x$10^4$was recorded after 1-day incubation of soil that received either 0 or 3.125% concentration of Carbofuran. Population of *Nitrosomonas spp* did not change at 14 to 21 days of incubation of soil that received 0% concentration of Carbofuran. The first day of incubation recorded the highest population while the 21st day of incubation recorded the lowest population. Regardless of days of incubation, 0% of Carbofuran recorded the highest population while 50% of Carbofuran recorded the lowest population. The decrease in population was more at 7th day and 21st day of incubation representing 48 - 86% and 95.5 - 97% increases respectively. With the exception of the 1st day of incubation, population of *Nitrosomonas spp* was halved as a result of soil treatment with 3.125% compared to control.

The survival rate of Nitrosomonas *spp* as affected by cyhalothrin pesticide is shown in Table 4. Result showed that *Nitrosomonas spp* had a high survival rate to the pesticide as they were all above 100% at every concentration exposed to and also for the duration of 21 days of incubation. The highest survival rate of 394.03% was recorded at 25% concentration of cyhalothrin incubated for 14 days and lowest was recorded at 3.125% concentration of cyhalothrin incubated for 21 days. Regardless of days of incubation, *Nitrosomonas spp* survived with increase in concentration of cyhalothrin.

Table 5 shows the % survival rate of *Nitrosomonas spp* when exposed to corbofuran pesticide. Result shows that 100.00% survival rate was recorded at 3.125% concentration of carbofuran incubated at 1 day and the lowest was at 50% concentration incubated for 21 days. The survival rate of *Nitrosomonas spp* changed by half on the 7th day of incubation with 3.125% concentration of carbofuran. The first day of incubation had the highest survival rate than the 21st day of incubation which recorded the lowest survival rate. The survival rate reduced with increase in concentration of treatment for all days of incubation.

Table 1: Selected Physical and Chemical Properties of the Soil

Soil properties	Value	Rating
Particle size Distribution (g/kg)		
Clay	66.4	-
Silt	70.0	-
Sand	863.6	-
Textural class	Sandy loam	
pH	6.89	Slightly acidic
Total Nitrogen (g/kg)	2.1	Moderately high

Table 2: Population of *Nitrosomonas spp* as affected by Cyhalothrin

	Incubation Days			
	1	7	14	21
Concentration (%)				
0	$6.4x10^4$	$6.7x10^4$	$6.7x10^4$	$23.2x10^4$
3.125	$7.6x10^4$	$8.0x10^4$	$9.3x10^4$	$25.0x10^4$
6.25	$7.9x10^4$	$8.0x10^4$	$10.8x10^4$	$27.3x10^4$
12.5	$8.2x10^4$	$8.2x10^4$	$17.0x10^4$	$33.6x10^4$
25	$8.5x10^4$	$8.6x10^4$	$26.4x10^4$	$33.6x10^4$
50	$8.6x10^4$	$8.7x10^4$	$33.6x10^4$	$35.2x10^4$

Table 3: Population of *Nitrosomonas spp* as affected by Carbofuran.

	Incubation Days			
	1	7	14	21
Concentrations (%)				
0	$16.8x10^4$	$14.4x10^4$	$5.1x10^4$	$51.0x10^4$
3.125	$16.8x10^4$	$7.5x10^4$	$2.4x10^4$	$2.3x10^4$
6.25	$16.0x10^4$	$4.4x10^4$	$2.2x10^4$	$2.0x10^4$
12.5	$14.4x10^4$	$2.3x10^4$	$2.0x10^4$	$1.65x10^4$
25	$12.0x10^4$	$2.3x10^4$	$1.88x10^4$	$1.63x10^4$
50	$10.4x10^4$	$1.96x10^4$	$1.64x10^4$	$1.59x10^4$

Table 4: % Survival rate of *Nitrosomonas spp* as affected byCyhalothrin Pesticide.

	Incubation Days			
	1	7	14	21
Concentrations (%)				
3.125	118.75	119.40	138.81	107.76
6.25	123.44	119.40	161.19	117.67
12.5	128.13	122.39	253.73	144.83
25	132.81	128.36	394.03	144.83
50	134.38	129.85	501.49	151.72

Table 5: % Survival rate of *Nitrosomonas spp* as affected by Carbofuran Pesticide.

	Incubation Days			
	1	7	14	21
Concentrations (%)				
3.125	100.00	52.08	47.06	4.51
6.25	95.24	30.56	43.14	3.92
12.5	85.71	15.97	39.22	3.24
25	71.43	15.97	36.86	3.20
50	61.91	13.61	32.16	3.12

Table 6 shows the derivation of Median Lethal Concentration (LC_{50}) from %log mortality of Cyhalothrin treatment on *Nitrosomonas spp*. Percentage mortality and Mean mortality were highest at low concentration of Cyhalothrin and lowest at high concentration of Cyhalothrin. The Median Lethal Concentration (LC_{50}) was derived as follows:

$$LC_{50} = LC_{100} - \frac{\sum(\text{concentration difference} \times \sum\%\text{mortality})}{\%\text{control}} \quad (1)$$

$$LC_{50} = \frac{50-(-)5034.47}{100} = 50+50.35 = 100.35\%$$

$$LC_{50} = 50 - (-)\frac{5034.47}{100}$$

$$= 50 + 50.35$$

$$LC_{50} = 100.35$$

The derivation of Median Lethal Concentration (LC_{50}) from % log mortality of Carbofuran treatment on *Nitrosomonas spp* is shown on Table 7. Percentage mortality and Mean mortality were directly proportional to the concentration of Carbofuran applied to the soil. The Median Lethal Concentration (LC_{50}) was derived as follow:

$$LC_{50} = LC_{100} - \frac{\sum(\text{concentration difference} \times \sum\%\text{mortality})}{\%\text{control}}$$

$$LC_{50} = \frac{50-3389.94}{100} = 50-33.899 = 16.10\%$$

The result obtained from the physical and chemical properties of the soil showed that it was sandy loam which is ideal for aerobic respiration because of the sand content (Doran *et al.*, 1996) and ideal for microbial nutrition because of the clay content that holds nutrient (Frossard *et al.*, 1995; Yaghi and Hartikainen, 2014). According to Esu (1991) rating for soil nutrient and reaction level, the pH of 6.89 was rated slightly acidic and ideal for macro nutrient availability as supported by Jensen *et al.* (2010). Total nitrogen of 2.1g Kg^{-1} was rated moderately high and indicated that the soil was seriously used for nitrogen fertilizer experiments by previous students.

The logarithm count for the population of *Nitrosomonas species* showed that the effect of Cyhalothrin and Carbonfuran pesticides could be stimulatory and harmful respectively to *Nitrosomonas species*.

The decrease in the percentage logarithm mortality of *Nitrosomonas spp* in the soil treated with Cyhalothrin pesticides during the 21days incubation to the different concentration of pesticides and the decrease in the percentage logarithm survival rate of *Nitrosomonas spp* in the soils treated with Carbofuran pesticide during 21days of incubation to different concentration of the pesticides demonstrated that the pesticide Carbofuran was toxic to the organism while Cyhalothrin pesticide was mild to the organism. Similar observation has been reported by Das and Mujahere, (1998). This may be as a result of its chemical composition and a degradability by the organism. The side of action of any pesticide depends on its nature. Obire and Owajo-Eli, (2014) stated that the effect of different pesticides on soil microorganisms depends on the composition of the pesticides which affect their diversity due to their xenobiotic nature.

The percentage log survival of *Nitrosomonas specie* during the 21days exposure period to the various concentrations of the pesticides (Tables 4 and 5) showed that the survival rate of Cyhalothrin pesticide was higher than that of Carbofuran implying that the Carbofuran pesticide exerted inhibitory effect on the microorganism leading to the reduction of viable cell counts. On the other hand, Cyhalothrin pesticide had stimulatory effect, indicating that it served as energy source for *Nitrosomonas spp* which was able to biodegrade and utilize it, resulting in increase in viable cell counts.

The reduction of viable cell count of *Nitrosomonas spp* due to Carbofuran pesticide may lead to inhibition of nitrifying process Obire and Owaji-Eli, (2014). Similar observation was made by Das and Mukherjee, (2000). Conversely, Cyhalothrin pesticide led to increase in growth of *Nitrosomonas spp*, which in turn is expected to increase nitrifying process. Similar observation was made by Williams and Dilosi, (2018).

Nitrosomonas specie mortality expressed as median lethal concentration (LC_{50}) was used as indices to monitor toxicity by Kpormon and Douglas, (2018). The median lethal concentration (LC_{50}) of Cyhalothrin on *Nitrosomonas* spp was 100.4% which was rated mild according to Toxicity Biomonitoring Chat of Kpormon and Douglas, (2018). Conversely, that of Carbofuran on *NItrosomonas* spp was 16.1%, and was rated toxic at high level according to Kpormon and Douglas, (2018). These were further confirmations of the mild and toxic effect of Cyhalothrin and Carbofuran pesticides respectively on survival of *Nitrosomonas spp* in the soils treated with these pesticides.

Table 6: Derivation of Median Lethal Concentration (LC_{50}) from % log mortality of cyhalothrin on *Nitrosomonas spp.*

Concentration (%)	%Mortality	Mean of mortality	Concentration difference	Sum. Conc.diff x mean mortality
0	-	-	-	-
3.125	-84.72	-21.18	3.125	-66.19
6.25	-121.70	-30.43	3.125	-95.09
12.5	-249.08	-62.27	6.25	-389.19
25	-400.03	-100.00	12.5	-1250.00
50	-517.44	-129.36	25	-3234.00
				$\sum$= -5034.47

Table 7: Derivation of Median Lethal Concentration (LC_{50}) from % log Mortality of Carbofuran on *Nitrosomonas spp.*

Concentration (%)	%Mortality	Mean of mortality	Concentration difference	Sum. Conc.diff x mean mortality
0	-	-	-	-
3.125	196.35	49.09	3.125	153.41
6.25	227.14	56.79	3.125	177.47
12.5	255.86	63.97	6.25	399.81
25	272.54	68.14	12.5	851.75
50	289.20	72.30	25	1807.50
				∑= 3389.94

Table 8. Pollution/toxicity bio-monitoring evaluation chart

Pollution/toxicity level	Lc50 range	Evaluatio
Level 1	≥75%	Mild or Insignificantly Toxic
Level 2	51-74%	Moderately Toxic [Low]
Level 3	41-50%	Moderately Toxic [High]
Level 4	21-40%	Toxic [High]
Level 5	11-20%	Toxic [Very High]
Level 6	1-10%	Acute Toxic
Level 7	>1	Extreme Toxic

4.0 Conclusions and Recommendations

The investigation demonstrated that the concentration of the pesticides used in this experiment has both negative and positive effect on the survival rate of *Nitrosomonas spp.* It shows that the Cyhalothrin pesticide can stimulate the growth of *Nitrosomonas spp* thereby increasing the rate of nitrification in the soil. Carbofuran pesticides on the other hand can cause more harm to Nitrosomonas species that play a very vital role in soil nitrification processes, hence could hinder the process.

It is therefore recommended that the use of Cyhalothrin pesticides be encouraged in nitrogen based cropping systems, since it stimulates the growth of *Nitrosomonas spp*, while the use of Carbofuran is discouraged, based on this study.

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