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Research article

MATHEMATICAL MODEL TO MONITOR SUBSTRATE DEPOSITION ON MIGRATION OF FUNGI INFLUENCED BY VOID RATIO IN ORGANIC AND LATERITIC SOIL IN WARRI DELTA STATE OF NIGERIA

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Abstract

The accumulation of substrate and fungi were confirm to deposit in organic and lateritic soil, the contaminants were found to deposit in different type of sources thus interact with other contaminant before meeting lateritic formation, the substrate deposition in organic soil leach down to lateritic soil were found in the strata through risk assessment investigation carried out in the study location, accumulation of fungi and the substrate in the strata can be attributed to low void ratio under the influence of constant regeneration of the contaminant including substrate deposition in organic and lateritic soil. To examine the deposition of this contaminants in the study location, mathematical model were developed through an expressed governing equation, this concept are applied to descretize the independed variables that influences the system at high rate of accumulation under the influence of substrate deposition in the formation, the study is imperative, because it will definitely express the level of fungi concentration , it also shows the interaction between the microbes and substrate expressed in organic and lateritic soil, the model will definitely monitor the behaviour of fungi and substrate in soil formation in the study area.

Keywords: mathematical model, substrate deposition, void ratio, and lateritic soil

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1. Introduction

Plant litter is one of the basis of generating primary nutrient saprophytic microbiota in soils, and its amount and properties strongly pressure the formation and humification of soil organic matter (SOM) in terrestrial ecosystems (Swift et al. 1979; Scholes et al. 1997; Kögel-Knabner 2002). Soil microbial biomass represents a significant compartment of terrestrial carbon, and its residues are important parent materials for humus formation (Haider 1992; Kögel-Knabner 2002).Growth of the microorganisms responsible for genesis and cycling of humic substances is influenced by carbon (C) and nitrogen (N) availability in the decomposing plant residues (Balser 2005). During plant residue decomposition, a fraction of the plant C and N is assimilated into the microbial biomass, rendering it largely inaccessible to further biological transformation. The assimilated C and N may remain unavailable to the plant and decomposer community for an appreciable time after microbial death (Jansson and Persson 1982). Little is known, however, about the fate of the C and N in the dead microbial cells. Soil amino sugars are predominantly of microbial origin (Parsons 1981; Stevenson 1982) and are relatively stable over time (Chantigny et al. 1997). The relative representation of different structural classes of amino sugars can be used to differentiate between fungal and bacterial residues in soils (Guggenberger et al. 1999; Glaser et al. 2004)

Understanding the fungal and bacterial contributions to microbial residues can further provide insights into how these organisms govern C and N cycling in soil (Amelung 2001; Simpson et al. 2004). The approach is based on existence of several distinct variations on the molecular structure of amino sugars, with two of them representative of bacteria and one of fungi (Nannipieri et al. 1979; Parsons 1981). Amino sugars are rapidly synthesized during microbial immobilization of inorganic N (McGill et al. 1973), regardless of the type of organic material added to soil (Sowden 1968). Lowe (1973) found that the amino sugar content of forest soils increases with respect to humification. Dai et al. (2002) showed that the level of amino sugar N, as a proportion of total N, remains constant or increases with time in arctic soil microcosms. Amelung et al. (2001) used amino sugars to investigate the fate of microbial residues during beech leaf (Fagus sylvatica L.) litter decomposition; however, their experiment was confined only to pure minerals and plant litters (not real soil). Little is known about the time scale at which amino sugars respond to introduced plant materials in soils.

2. Theoretical background

The migration of fungi is one the microbes that deposit on soil between the micropores of the soil, the deposition of this microbes are determined by the soil structural stratifications of the formation in deltaic environment, the deposition of fungi in most condition can be attributed to constant regeneration of the contaminant through the indiscriminant dumping of biological waste in the study area. Rapid increasing of the contaminants it is subject of concern in the study location, because of the hazardous consequences generating in human settlement, the deposition of fungi on rapid increase in the formation were confirm through thorough investigation from the soil and water, the deposition of substrate in soil definitely enhance the growth rate of the microbes in the transport process, dispersions of the contaminants were confirm from the risk assessment carried out on the soil , results from the assessment shows the rate of concentration from organic to lateritic soil, the formation are in the horizon A formation. High concentration in organic and lateritic soil are base on the low porosity deposition in the strata including constant regeneration of the contaminants in the study area, environmental effect were also found to contributes its quota on high concentration of the formation.,. Developed of mathematical equation were found suitable to monitor the deposition of fungi under the influence of substrate in organic and lateritic formation, the developed mathematical equation will definitely assess the rate of concentration in the study area.

3. Governing equation

Nomenclature

ϕ	-	Porosity Dimensionless
V	-	Void ratio
D	-	Dispersion
K_c	-	Coefficient of inhibition [ML^{-3}]
K_o	-	Half concentration of fungi [ML^{-3}]
K_n	-	Half concentration of fungi under aerobic respiration [ML^{-3}]
C	-	Concentration of fungi [ML^{-3}]
T	-	Time [T]
Z	-	Distance [M]

3. Governing equation

$$\phi \frac{\partial C}{\partial t} = V \frac{\partial C}{\partial z} + D \frac{\partial C}{\partial z} - K_c \frac{\partial C}{\partial z} + K_o \frac{\partial C}{\partial t} + K_n \frac{\partial C}{\partial z} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

$$\phi \frac{\partial C_1}{\partial t} = V \frac{\partial C_1}{\partial z} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

$$\left.\begin{array}{l} t = 0 \\ z = 0 \\ C_{(o)} = 0 \\ \frac{\partial C_1}{\partial t} \Big| t = 0,\ B \end{array}\right\} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

$$\phi \frac{\partial C}{\partial t} = D \frac{\partial C}{\partial z} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (4)$$

$$\left.\begin{array}{l} t = 0 \\ z = 0 \\ C_{(o)} = 0 \\ \frac{\partial Cs_2}{\partial t} \Big| t = 0,\ B \end{array}\right\} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (5)$$

$$\phi \frac{\partial C_3}{\partial t} = - K_c \frac{\partial C_3}{\partial z} \qquad \text{.................} \qquad (6)$$

$$t = 0$$
$$z = 0$$
$$C_{(o)} = 0$$

$$\frac{\partial C_3}{\partial t} \Big| t = 0, B \qquad \text{.................} \qquad (7)$$

$$\phi \frac{\partial C_4}{\partial t} = K_o \frac{\partial C_4}{\partial z} \qquad \text{.................} \qquad (8)$$

$$\left. \begin{aligned} & t = 0 \\ & z = 0 \\ & C_{(o)} = 0 \\ & \frac{\partial Cs_4}{\partial t} \Big| t = 0, B \end{aligned} \right\} \qquad \text{.................} \qquad (9)$$

The concept of this principle applied is to descretized equations base to various situation that the substrate influence the microbes under the influence of stratification of the formation at various depths from t organic and lateritic soil, this condition establish are very essential the rate of fungi increase is subject of concern in organic and lateritic soil formation, thus it is also imperative to ensure that the substrate is thoroughly examined to monitor the rate of deposition at various formation, thus predict their depositions in organic and lateritic soil in the formation study area.

$$K_o \frac{\partial C_5}{\partial t} + K_n \frac{\partial C_5}{\partial z} = 0 \qquad \text{.................} \qquad (10)$$

$$\left. \begin{aligned} & t = 0 \\ & z = 0 \\ & C_{(o)} = 0 \\ & \frac{\partial C_5}{\partial t} \Big| t = 0, B \end{aligned} \right\} \qquad \text{.................} \qquad (11)$$

$$K_o \frac{\partial C_6}{\partial t} - K_c \frac{\partial C_6}{\partial z} \qquad \text{.................} \qquad (12)$$

$$\left. \begin{aligned} & t = 0 \\ & z = 0 \\ & Cs_{(o)} = 0 \end{aligned} \right\}$$

$$\frac{\partial C_6}{\partial t}\Big| t = 0,\ B \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (13)$$

$$K_o \frac{\partial C_7}{\partial t} + V \frac{\partial C_7}{\partial z} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (14)$$

$$\left.\begin{array}{l} t = 0 \\ z = 0 \\ C_{(o)} = 0 \\ \dfrac{\partial Cs_7}{\partial t}\Big| t = 0,\ B \end{array}\right\} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (15)$$

$$K_o \frac{\partial C_8}{\partial t} + D \frac{\partial C_8}{\partial z} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (16)$$

$$\left.\begin{array}{l} t = 0 \\ z = 0 \\ Cs_{(o)} = 0 \\ \dfrac{\partial C_8}{\partial t}\Big| t = 0,\ B \end{array}\right\} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (17)$$

Applying direct integration on (2) we have

$$\phi \frac{\partial C}{\partial t} = V + K_1 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (18)$$

Again, integrate equation (18) directly yield

$$\phi C = V + K_1 + K_2 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (19)$$

Subject to equation (3), we have

$$C = K_2 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (20)$$

And subjecting equation (19) to (3)

$$\text{At } \frac{\partial C_1}{\partial t}\Bigg|\begin{array}{l} = 0 \\ t = 0 \end{array} \quad C_{(o)} = C_o$$

Yield

$$0 = \phi C_o + K_2$$

$$\Rightarrow K_2 = \phi C_o \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (21)$$

So that we put (20) and (210 into (19), we have

$$C_1 = \phi Ct - Vt + C_o \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (22)$$

$$C_1 - \phi = C_o - Vt \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (23)$$

$$\Rightarrow C_1 \left[C_1 - \phi t\right] = C_o \left[C_1 - Vt\right] \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (24)$$

$$\Rightarrow Ct = C_o \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (25)$$

$$\phi \frac{\partial C_2}{\partial t} = D \frac{\partial C_2}{\partial z} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (4)$$

We approach this system using the Bernoulli's method of separation of variables.

i.e. $C_2 = ZT$ ……………… (26)

$$\frac{\partial C_2}{\partial t} = ZT^1 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (27)$$

$$\frac{\partial C_2}{\partial z} = Z^1 T \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (28)$$

Put (27) and (28) into (26), so that we have

$$\phi Z T^1 = VZT^1 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (29)$$

$$\phi \frac{T^1}{T} = V \frac{Z^1}{Z} = \lambda^2 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (30)$$

Hence $\frac{T^1}{T} = -\lambda^2$ ……………… (31)

$$VZ^1 + \lambda^2 Z = 0 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (32)$$

From (32) $T = ACos \frac{\lambda t}{\phi} + B\ Sin \frac{\lambda z}{\phi}$ ……………… (33)

And (32) gives $T = \frac{-\lambda^2}{C\ell^{v}} t$ ……………… (34)

By substituting (32) and (33) into (26)

$$C_2 = \left[ACos \frac{\lambda}{\sqrt{\phi}} t + B\,Sin \frac{\lambda}{\sqrt{\phi}} x \right] Co\ell^{\frac{-\lambda^2}{\sqrt{\phi}} t} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (35)$$

$$C_o = Ac \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (36)$$

Equation (2) derived by straight incorporation of some parameters in harmony with the system, directed incorporation were found essential to couple the variables that have similarity, base on the deposition of fungi reflecting on high concentration of the microbes in organic and lateritic soil the influence from high degree of void ratio may experience high degree of concentration of the contaminants. Variables were found to express their relation with each other in terms of there pressure of increase through the deposition of substrate and increase in microbial population in organic and lateritic soil were the accumulations of the contaminant are very high.

Equation (35) becomes

$$C_2 = C_o \ell \frac{-\lambda^2}{D} t \ Cos \frac{\lambda}{\phi} z \qquad \text{.....................} (37)$$

Again at $\left. \frac{\partial Cs_2}{\partial t} \right| \begin{matrix} = 0, \ z = 0 \\ t = 0, \ B \end{matrix}$

Equation (37) becomes

$$\frac{\partial C_2}{\partial t} = \frac{\lambda}{\phi} C_o \ell^{\frac{-\lambda^2}{D} t} \ Sin \frac{\lambda}{\phi} z \qquad \text{.....................} (38)$$

i.e. $0 = -C_o \frac{\lambda}{\sqrt{\phi}} \ Sin \frac{\lambda}{\sqrt{\phi}} 0 \qquad \text{.....................} (39)$

$C_o \frac{\lambda}{\sqrt{\phi}} \neq 0$ Considering NKP

$$0 = -C_o \frac{\lambda}{\phi} \ Sin \frac{\lambda}{\phi} B \qquad \text{.....................} (40)$$

$$\lambda = \frac{n\pi\sqrt{\phi}}{2} \qquad \text{.....................} (41)$$

So that equation (38) becomes

$$C_2 = C_o \ \ell^{\frac{-n^2\pi^2\phi}{2D}} \ Cos \frac{n\pi\sqrt{\phi}}{2\sqrt{\phi}} x \qquad \text{.....................} (42)$$

$$C_2 = C_o \ \ell^{\frac{-n^2\pi^2\phi}{2D}} \ Cos \frac{n\pi}{2} x \qquad \text{.....................} (43)$$

We consider equation (6)

$$\phi \frac{\partial C_3}{\partial t} = -K_c \frac{\partial C_3}{\partial z} \qquad \text{.....................} (6)$$

We approach the system by using Bernoulli's method of separation of variables.

$$C_3 = ZT \qquad \text{.....................} (44)$$

$$\frac{\partial C_3}{\partial t} = ZT^1 \qquad \text{.....................} \quad (45)$$

$$\frac{\partial C_3}{\partial z} = Z^1 T \qquad \text{.....................} \quad (46)$$

Hence, we put (45) and (46) into (44), so that we have

$$\phi \frac{ZT^1}{T} = K_c \frac{Z^1 T}{T} \qquad \text{.....................} \quad (47)$$

$$\text{i.e. } \phi \frac{VT^1}{T} = K_c \frac{Z^1}{Z} - \lambda^2 \qquad \text{.....................} \quad (48)$$

$$\text{Hence } V \frac{T^1}{T} + \lambda^2 = 0 \qquad \text{.....................} \quad (49)$$

$$\text{i.e. } Z^1 + \frac{\lambda^2}{\phi} Z = 0 \qquad \text{.....................} \quad (50)$$

$$\text{And } K_c T^1 + \lambda^2 T = 0 \qquad \text{.....................} \quad (51)$$

$$\text{From (50) } Z = ACos \frac{\lambda}{\phi} Z + BSin \frac{\lambda}{\phi} Z \qquad \text{.....................} \quad (52)$$

And (45) gives

$$T = C_o \ell^{\frac{-\lambda^2}{K_c} t} \qquad \text{.....................} \quad (53)$$

By substituting (52) and (53) into (44), we get

$$C_3 = \left[ACos \frac{\lambda}{\phi} Z + B\,Sin \frac{\lambda}{\sqrt{\phi}} Z \right] Cos \ell^{\frac{-\lambda^2}{K_c} t} \qquad \text{.....................} \quad (54)$$

Subject (54) to condition in (6) so that we have

$$C_o = Ac \qquad \text{.....................} \quad (55)$$

related conditions are expressed in equation (55) the depositions of microelements' migrating in organic and lateritic soil are found to deposit very high concentration of substrate, due the low permeability and void ratio content, therefore the tendency of accumulation waiting for high degree of saturation to enable were expressed, this is migrate to were there sight increase in permeability deposition can be were experienced the migration process of fungi are under the influence of high degree of saturation, similarly, the condition developed the composition of these parameters by the integration in equation (55) were the concentration of fungi will normally be at initial condition, so the formation strata determined the expressed variable that developed model denoted as C_s = Ac in equation (55).

Equation (56) becomes

$$C_3 = C_o \ell \frac{-\lambda^2}{K_c} t \; Cos \frac{\lambda}{\phi} Z \qquad \text{.....................} \quad (56)$$

Again at $\left. \frac{\partial C_3}{\partial t} \right| \; t = 0, \; B$

Equation (56) becomes

$$\frac{\partial C_3}{\partial t} = \frac{\lambda}{\sqrt{\phi}} Cos \frac{-\lambda^2}{K_c} \; Sin \frac{\lambda}{\phi} z \qquad \text{.....................} \quad (57)$$

i.e. $0 = -C_o \frac{\lambda}{\sqrt{\phi}} \; Sin \frac{\lambda}{\sqrt{\phi}} 0$

$C_o \frac{\lambda}{\phi} \neq 0$ Considering NKP

Which is the substrate utilization for microbial growth rate (population) so that

Equation (40) and (57) express the influence of the substrate in terms of increase in microbial population, this condition were considered in these two equations, microbial population express in the system considered in the to increase in a situation were microbes are predominant. The equations take care of the rate of fungi deposition in the formations, the equation in (40) and (55) were expressed the results of fungi deposition in the formations, the above expressed equation reflect the consequences of fungi deposition, there the tendency of microbial population increase, including high rate of from the substrate deposition in the formations. This condition generates lots of variations in microbial behaviour in different dimensions. Moreso the degree of substrate considered in the state of microbial transport determined the rate of inhibition from other influence that deposit in organic and lateritic soil formation.

$$0 = -C_o \frac{\lambda}{\phi} \; Sin \frac{\lambda}{\phi} B \qquad \text{.....................} \quad (58)$$

$$\Rightarrow \frac{\lambda}{\sqrt{\phi}} = \frac{n\pi^2}{2} \qquad \text{.....................} \quad (59)$$

$$\Rightarrow \lambda = \frac{n\pi\sqrt{\phi}}{2} \quad \text{.................... (60)}$$

So that equation (52)

$$C_3 = C_o \, \ell^{\frac{-n^2\pi^2\phi}{2K_c}} \; Cos \frac{n\pi\sqrt{\phi}}{2\sqrt{\phi}} Z \quad \text{................. (61)}$$

$$\Rightarrow C_3 = C_o \, \ell^{\frac{-n^2\pi^2\phi}{2K_c}t} \; Cos \frac{n\pi}{2} Z \quad \text{.................... (62)}$$

Now we consider equation (8)

$$\phi \frac{\partial C_4}{\partial t} = K_o \frac{\partial C_4}{\partial z} \quad \text{.................... (8)}$$

Using Bernoulli's method of separation of variables, we have

$$C_4 = ZT \quad \text{................. (63)}$$

$$\frac{\partial C_4}{\partial t} = ZT^1 \quad \text{................. (64)}$$

$$\frac{\partial C_4}{\partial Z} = Z^1 T \quad \text{................. (65)}$$

$$\phi ZT = -K_o \, Z^1 T \quad \text{................. (66)}$$

i.e.

$$\phi \frac{T^1}{T} = K_o \frac{Z^1}{Z} = \varphi \quad \text{................. (67)}$$

$$\phi \frac{T^1}{T} = \varphi \quad \text{................. (68)}$$

$$K_o \frac{Z^1}{Z} = \varphi \quad \text{................. (69)}$$

And

$$Z = B\ell^{\frac{\varphi}{K_o}Z} \quad \text{................. (70)}$$

Put (68) and (69) into (63), gives

$$C_4 = A\ell^{\frac{\varphi}{K_o}Z} \; B\ell^{\frac{\varphi}{K_o}t} \quad \text{................. (71)}$$

$$Cs_4 = AB\ell^{(z-t)} \frac{\varphi}{K_o} \quad \text{................. (72)}$$

Subject equation (70) to (8) yield

$$C_4 = (o) = C_o \qquad \text{.................} \quad (73)$$

So that equation (73) becomes

$$C_4 = C_o \ell^{(t-z)} \frac{V}{K_o} \qquad \text{.................} \quad (74)$$

Now, we consider equation (10)

$$K_o \frac{\partial C_5}{\partial t} + K_n \frac{\partial C_5}{\partial z} \quad \text{...........} \qquad (10)$$

Apply Bernoulli's method, we have

$$C_5 = ZT \qquad \text{.................} \quad (75)$$

$$\frac{\partial C_5}{\partial t} = ZT^1 \qquad \text{.................} \quad (76)$$

$$\frac{\partial C_5}{\partial Z} = Z^1 T \qquad \text{.................} \quad (77)$$

Put (75) and (76) into (10), so that we have

$$K_o \; ZT^1 = -Z^1 T \, K_n \qquad \text{.................} \quad (78)$$

i.e. $K_o \frac{T^1}{T} = \frac{Z^1}{Z} K_n = \alpha$ .... (79)

$$K_o \frac{T^1}{T} = \alpha \qquad \text{.................} \quad (80)$$

$$K_n \frac{Z^1}{Z} = \alpha \qquad \text{.................} \quad (81)$$

$$T = \frac{\alpha}{K_o} t \qquad \text{.................} \quad (82)$$

$$Z = B\ell^{\frac{-\alpha}{K_n} Z} \qquad \text{.................} \quad (83)$$

And

Put (80) and (81) into (73), gives

$$C_5 = A \frac{\alpha}{K_n} t \; \frac{-\alpha}{K_n} t \qquad \text{.................} \quad (84)$$

$$C_5 = AB\ell^{(z-t)} \frac{\alpha}{K_n} \qquad \text{.................} \quad (85)$$

Subject equation (83) and (84) into (74) yield

$$C_5 = (o) = C_o \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (86)$$

So that equation (84) and (85) becomes

$$Cs_5 = (o) = Cs_o \; \ell^{(x-t)} \frac{\alpha}{K_n} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (87)$$

Now, we consider equation (12)

$$K_o \frac{\partial Cs_6}{\partial t} - K_n \frac{\partial Cs_6}{\partial z} = 0 \quad \ldots\ldots\ldots \quad (12)$$

Applying Bernoulli's method of separation of variables, we have

$$C_6 = ZT \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (88)$$

$$\frac{\partial C_6}{\partial t} = ZT^1 \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (89)$$

$$\frac{\partial C_6}{\partial Z} = Z^1 T \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (90)$$

$$ZT^1 K_o - K_o Z^1 T \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (91)$$

i.e. $K_o \frac{T^1}{T} = K_c \frac{Z^1}{Z} = \rho \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (92)$

$$K_o \frac{T^1}{T} = \rho \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (93)$$

$$K_c \frac{Z^1}{Z} = \rho \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (94)$$

And $Z = B\ell^{\frac{-\rho}{K_o} z} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (95)$

Put (94) and (95) into (88) gives

$$C_6 = A\ell^{\frac{A-\rho}{K_c} t} \bullet B\ell^{\frac{\rho}{K_c} t} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (96)$$

$$C_6 = AB\ell^{(z-t)} \frac{\rho}{K_c} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (97)$$

Subject equation (95) and (96) into (97) yield

$$C_6 = (o) = C_o \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (98)$$

So that equation (95 and (98) becomes

$$C_6 = C_o \, \ell^{(t-z)\frac{\rho}{K_c}} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (99)$$

We consider equation (14)

$$K_o \frac{\partial C_7}{\partial t} + V \frac{\partial C_7}{\partial z} \qquad \ldots\ldots\ldots\ldots \qquad (14)$$

$$C_7 = ZT \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (100)$$

$$\frac{\partial C_7}{\partial t} = ZT^1 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (101)$$

$$\frac{\partial C_7}{\partial Z} = Z^1 T \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (102)$$

Put (100) and (101) into (14), so that we have

$$C\theta ZT^1 = V\theta Z^1 T \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (103)$$

i.e. $C\theta \frac{T^1}{T} = V\theta \frac{Z}{Z}$ ……………… (104)

$$C\theta \frac{T^1}{T} = \rho \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (105)$$

$$V\theta \frac{Z^1}{T} = \rho \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (106)$$

$$T = A \frac{\rho}{C\theta} t \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (107)$$

And $Z = B\ell^{\frac{-\rho}{V\theta} Z}$ ……………… (108)

Put (106) and (107) into (100), gives

$$C_7 = A \frac{\rho}{V\theta} t \; B \frac{\rho}{V\theta} Z \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (109)$$

$$C_7 = AB\ell^{(z-t)} \frac{\rho}{V\theta} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (110)$$

Subject equation (108) and (109) into (100) yield

$$C_7 = (o) = C_o \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (111)$$

So that equation (109) and (110) becomes

$$C_7 = C\theta \ell^{(t-z)} \frac{\rho}{V\theta} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (112)$$

Now, we consider equation (16) which is the steady plow rate of the system

$$C\theta \frac{\partial C}{\partial t} + D \frac{\partial C}{\partial z} \qquad \ldots\ldots\ldots\ldots \qquad (16)$$

Applying Bernoulli's method, we have

$$C_8 = ZT \quad \text{.................} \quad (113)$$

$$\frac{\partial C_8}{\partial t} = ZT^1 \quad \text{.................} \quad (114)$$

$$\frac{\partial C_8}{\partial Z} = Z^1 T \quad \text{.................} \quad (115)$$

Put (113) and (114) into (16), so that we have

$$C\theta ZT^1 = DZ^1 T \quad \text{.................} \quad (116)$$

i.e. $C\theta \frac{T^1}{T} = D\frac{Z^1}{Z}$ .... (117)

$$C\theta \frac{T^1}{T} = \theta \quad \text{.................} \quad (118)$$

$$D\frac{Z^1}{Z} = \theta \quad \text{.................} \quad (119)$$

$$Z = A\frac{\theta}{C\theta} Z \quad \text{.................} \quad (120)$$

And $T = B\frac{\theta}{D} t$ .... (121)

Put (119) and (121) into (113), gives

$$C_8 = A\ell^{\frac{\theta}{C\theta}} \bullet B\ell^{\frac{\theta}{D}} \quad \text{.................} \quad (122)$$

$$C_8 = AB = \ell^{(t-z)} \frac{\theta}{D} \quad \text{.................} \quad (123)$$

Subject to equation (122) and (123) yield

$$C_8 = (o) = C_o \quad \text{.................} \quad (124)$$

So that equation (125) becomes

$$C_8 = C_o \ell^{(t-z)} \frac{\theta}{D} \quad \text{.................} \quad (125)$$

The development of Steady state in the system were expressed in equation in (125), the deposition of fungi were expressed under the influences of formation difference in deposition in the strata. This state of there formation experience homogeneous deposition at different texture the substrate and fungi maintained uniformity concentration in deposition in organic and lateritic soil formation, it implies that in horizon A, formation of the soil, there is the tendency of uniform flow of the substrate and microbial concentration in the formation, therefore such condition may result to uniform flow and from the substrate and fungi concentration, so equation (125) expressed such condition in the system, this reflect the behaviour assumed in the migration of the contaminant and the deposition of fungi in the study location.

Now, assuming that at the steady flow, there is no NKP for substrate utilization, our concentration is zero, so that equation (124) becomes

$$C_8 = 0 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (126)$$

Therefore, solution of the system is of the form

$$C = C_1 + C_2 + C_3 + C_4 + C_5 + C_6 + C_7 + C_8 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (127)$$

We now substitute (25), (43), (62), (74), (87), (99), (110) and (125) into (128), so that we have the model of the form

$$C = C_o + C_o \, \ell \frac{-n^2\pi^2 K}{2D} Cos \frac{n\pi}{2} Z + \ell \frac{-n^2\pi^2 K}{2V\theta} t \; Cos \frac{\sqrt{V}}{2} Z +$$

$$C_o \, \ell^{(t-z)} \frac{K}{C\theta} + C_o \, \ell^{(z-t)} \frac{\phi}{V} + C_o \, \ell^{(t-z)} \frac{\alpha}{V\theta} +$$

$$C_o \ell^{(t-z)} \frac{\rho}{V\theta} + C_o \ell^{(t-z)} \frac{\theta}{D} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (128)$$

$$\Rightarrow C = C_o \; 1 + \ell \frac{-n^2\pi^2 K}{2D} Cos \frac{n\pi}{2} + \ell \frac{-n^2\pi^2 K}{2V\theta} t \; Cos \frac{n\pi}{2} Z + C_o \, \ell^{(t-z)} \frac{K}{C\theta}$$

$$+ C\theta \, \ell^{(z-t)} \frac{\phi}{V} + C\theta \, \ell^{(t-z)} \frac{\alpha}{V\theta} + C\theta \ell^{(t-z)} \frac{\rho}{V\theta} + C\theta \, \ell^{(t-z)} \frac{\theta}{D} \qquad (129)$$

The derived mathematical model in (129) is the final model phase that monitor the substrate deposition on migration of fungi in organic and lateritic soil, the modified equation considered several conditions that could influence the deposition of fungi in the study location. The deposition of substrate and fungi were investigated thoroughly from different conditions through risk assessment in the study location, these process were itemizes, in modifying the developed governing equation, several conditions that influence the behave of substrate and fungi deposition were also expressed in the system, microbial growth determined the population of the microbe in organic and lateritic, these condition were streamlined in the derived model at various stage, the behaviour of fungi deposition express the concentration variables denoted mathematically in the system, this condition were determined through the boundary values as express in the model equation, different stages were expressed on the process of developing the model denoting it through various mathematical tools, the deposition of organic and lateritic formations including , the rate of concentration of the substrate determined the rate of growth rate of microbes under normal condition, situations were the deposition are very high and there is degradation of the microbes were also considered in the system as it was expressed on the derived mathematical expression. The model if applied will definitely monitored and determine the deposition and growth rate of fungi in organic and lateritic soil.

4. Conclusion

The deposition of fungi in organic and lateritic soil formation has been expressed, the model ere derived in stages considering the behaviour of the microbes in organic and lateritic soil formation, the study location are naturally deltaic, such formations reflect the deltaic influence, the degree of void ratio were expressed in the system , because it influence the accumulation of fungi and substrate in the formation, the expressed model in the study are established to monitor the depositions of fungi and microelements base on the formation stratification expressed in the study location Warri Delta state. The derived mathematical equation will definitely monitor the deposition of fungi in organic and lateritic soil formation.

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