

Mathematical Model of the Effect of Hyphal Death on Y-X Types of Fungi with Energy

<https://doi.org/10.31185/wjcm.VolX.IssX.XX>

Noor Raad Fawzyi

Education College for Pure Sciences, Wasit University, Iraq
noorraad674@gmail.com

Ali Hussian Shuaa

Education College for Pure Sciences, Wasit University, Iraq
shuaa@gmail.com

Abstract— The mathematical model is described by the dysplasia phenomenon. The model depicts the growth of dichotomous Branching, Tip Death Due to Overcrowding limb anastomosis, and limb death owing to thread death due to congestion. The study demonstrates energy use in general Fungi growth must be resolved till the goal becomes a corrective. Furthermore, the research decreased costs and effort by predicting the optimum plant class for each situation cultivation based on the outcomes We propose a mathematical solution here utilizing partial differential equations to solve (PDEs). Furthermore because of some of the issues MATLAB software codes were used for numerical analysis We have issues with direct mathematical solutions Finally, the research models demonstrate whether the growth of the company was successful or not. [6]

Keywords— Dichotomous Branching, Tip Death Due to Overcrowding.

1. Introduction

The mathematical model theoretically describes an object that exists outside the field of mathematics. We note in the mathematical model three stages:

- 1.1 *Construction, the process in which an object is transformed into a mathematical language.*
- 1.2 *Analysis or study of the prepared form.*
- 1.3 *Interpretation of the said analysis, in which the results of the study are applied to the object from which it was divided.*

The benefit of such models is that they help to study how complex structures behave when faced with situations that are not easily visible in the real world. There are models working in

certain cases and not accurate in other cases, as happens with mechanics Newtonian, who verified their credibility by Albert Einstein himself. The benefit of such models is that they help to study how complex structures behave when faced with situations that are not easily visible in the real world.

There are models working in certain cases and not accurate in other cases, as happens with mechanics Newtonian, table (1) show some branches of types of fungi and describe biological types and put these biologist phenomena as mathematical form as version, and illustrate the parameters description. In this model we mix some types of fungi [7]

Open the document you would like to format and import the styles. How this works depends very much on the version of MS WORD that you use. The styles' names to be used for Wasit Journal of Computer and Mathematic Science are preceded by a "0_" which makes them appear first in the styles list and therefore easier to be found.

Now just place the cursor in the paragraph you would like to format and click on the corresponding style in the styles window (or ribbon).

2. Mathematical Model

We will study a new type of branching of fungal growth with Hyphal death and Consumption of whole vegetarian food, we can call it energy , this energy function lies between one and zero as Here if means if the grow die if it is not consume energy but that mean is the growth is very good if the fungi

BIOLOGICAL TYPE	$\sigma(n, p)$	SYMBOL	PARAMETERS DESCRIPTION
Dichotomous Branching	$\sigma = -\alpha_1 n$	Y	α_1 is the loss rate of tips (constant for tip death)
Tip Death Due	$\sigma = -\beta_3 p^2$	X	β_3 is the rate of tip reconnections per unit time
Hyphal death	$d = \gamma_1 p$	D	γ_1 is the loss rate of hyphal (constant for hyphal death)

Table (1-1): Biological Type, Symbol of This Type, Version and Shape. [6]

α_1 is the loss rate of tips (constant for tip death)
 β_3 is the rate of tip reconnections per unit time
 γ_1 is the loss rate of hyphal (constant for hyphal death)
 we can describe Hyphal growth by the system:

$$\sigma(n, p) = YX \tag{1}$$

Where Y refers to Dichotomous Branching, and X refers to Tip Death Due to Overcrowding. The model system for this type is:

$$\begin{aligned} \frac{\partial p}{\partial t} &= n - p \\ \frac{\partial n}{\partial t} &= -\frac{\partial n}{\partial x} + \alpha(n - p^2) \end{aligned} \tag{2}$$

Where: $\alpha = \frac{\alpha_1}{\gamma}$. Some techniques to solve the above system:

3. The Stability of Solution

In this section, we will illustrate stability of system (2), as

$$\begin{aligned} n - p &= 0 \\ \alpha(n - p^2) &= 0 \end{aligned} \tag{3}$$

The solution of these equations, we will find values of (p, n), the steady-state are:(0, 0), and (1, 1), We following the same precedent in (3.2.1) to find the determinate eigenvalue of λ , we get two of the value of λ in (0, 0) :- $\lambda_1 = -1$, $\lambda_2 = \alpha$. The stability of the steady-state depended on the value of α ; if α is positive, we get the steady-state of (0, 0) is a saddle point, while the (1, 1) is an unstable spiral; if α is negative, we get the steady-state of (0, 0) is a stable node, while the (1, 1) is as addle point

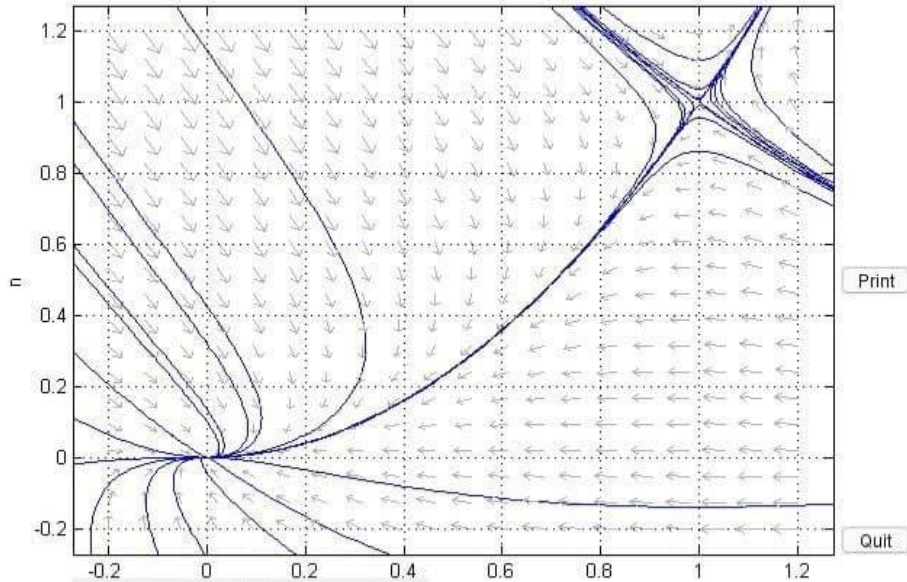


Fig (1) the (p, n)-plane for ordinary differential equation (2), where note that: when if $\alpha = -2$, the solid blue line corresponds the model a trajectory connects the saddle point (1, 1) to the stable node (0, 0) solutions are produced using MATLAB pplane7

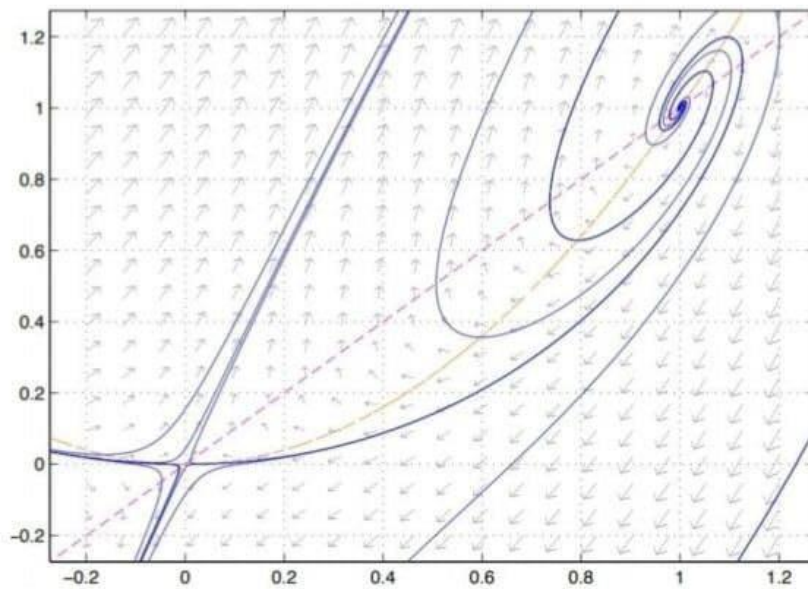


Fig (2): In figure (1), when if $\alpha = 2$, the solid blue line corresponds the model trajectory connects the unstable spiral (1, 1) to the saddle point (0, 0).solutions are produced using MATLAB pplane7.

4. Traveling Wave Solution

Hence we seek traveling wave solutions to (2). A mathematical way of saying this that we seek solutions of the form:

$$\begin{aligned} \mathbf{p}(\mathbf{x}, t) &= \mathbf{P}(\mathbf{z}) \\ \mathbf{n}(\mathbf{x}, t) &= \mathbf{N}(\mathbf{z}) \end{aligned} \quad (4)$$

Where $z = x-ct$. Here $P(z)$, $N(z)$ represents density profiles, and c can be interpreted as the rate of propagation of the colony edge. For these to be biologically meaningful, we require P and N to be bounded, non-negative functions of z . Then $p(x, t)$ and $n(x, t)$ are a traveling wave, and it moves at a constant speed c in the positive x - direction if c positive. Clearly if $(x-ct)$ is constant, so are $p(x, t)$ and $n(x, t)$. It also means the coordinate system moves with speed c . The wave speed c generally has to be determined. The dependent variable z is sometimes called the wave variable. When we look for traveling wave solutions of an equation or system of equations in x and t in the form (2), Thus we can reduce the system (2) to a set of two ordinary differential equation:

$$\begin{aligned} \frac{dp}{dz} &= -\frac{1}{c} [N - P] \\ \frac{dN}{dz} &= \frac{1}{1-c} [\alpha(N - P)], \quad c \neq 1, \quad -\infty < z < \infty \end{aligned} \quad (5)$$

5. Stability of Traveling Waving Solution

The system has two uniform steady-state points $(0,0)$, and $(1,1)$. we following the same precedent in(3.2.1) to find the determinate eigenvalue of λ , we get two of the value of λ in $(0,0)$: $\lambda_1 = \frac{1}{c}$, $\lambda_2 = -\frac{\alpha}{c-1}$ while the value of λ in $(1,1)$

Where $c \neq 0$, and $c \neq 1$. The stability of the steady-state depended on the value of α and c ; in case α is positive, if $c < 1$, we get the steady-state of $(0, 0)$ is a saddle point, while the $(1, 1)$ is an unstable spiral, but if $c > 1$, we get the steady-state of $(0, 0)$ is a saddle point, while the $(1, 1)$ is a stable spiral; in case α is negative, if $c < 1$, then the steady-state of $(0, 0)$ is a stable node, and the $(1, 1)$ is a saddle point, but if $c > 1$ the steady-state of $(0, 0)$ is an unstable node the $(1, 1)$ is saddle point.

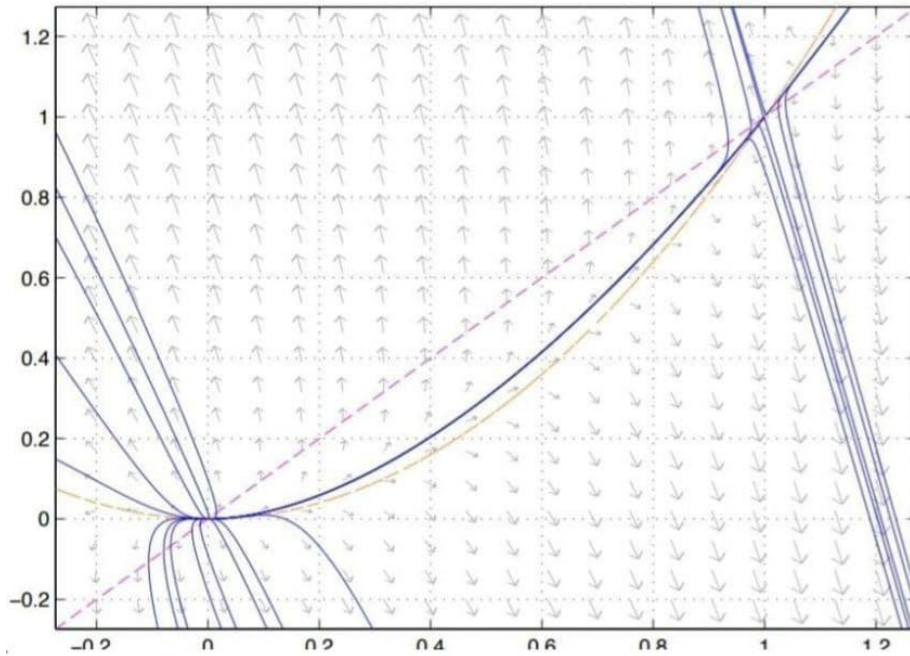
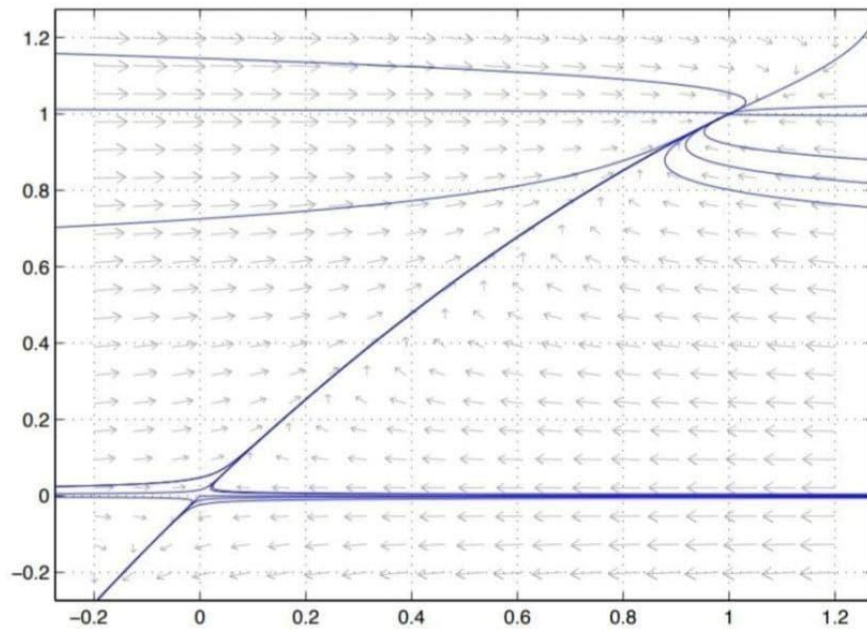
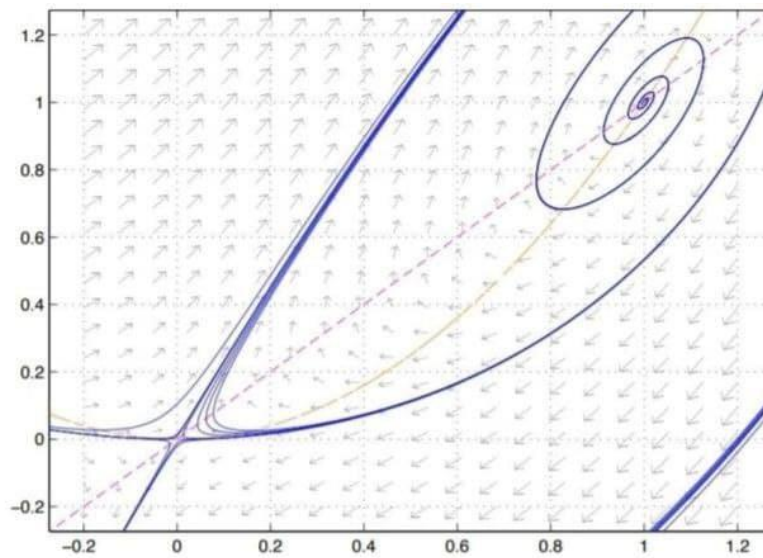


Fig (3) the (p,n)-plane, note that trajectories connect in Fig (2),the saddle point (1,1) to the stable node (0, 0) when $c = -2$, $\alpha = -2$,solutions are produced using MATLAB pplane7.



Fig(4) the saddle point (1,1) to the unstable node (0,0) when $c=2, \alpha = -2$ solutions are produced using MATLAB pplane7.



Fig(5) the unstable spiral (1, 1) to the saddle point (0, 0) when $c = -2, \alpha = 2$ solutions are produced using MATLAB pplane7.

6. Numerical Solution

To show the behavior of the branch and tips, we will be using pdepe code in MATLAB to solve the following system:

$$\begin{aligned} \frac{\partial p}{\partial t} &= \mathbf{n} - \mathbf{p} \\ \frac{\partial n}{\partial t} &= -\frac{\partial n}{\partial x} + \alpha(\mathbf{n} - p^2) \end{aligned} \quad (6)$$

See the Fig (6) showing the initial condition of branch (p) and tips (n)

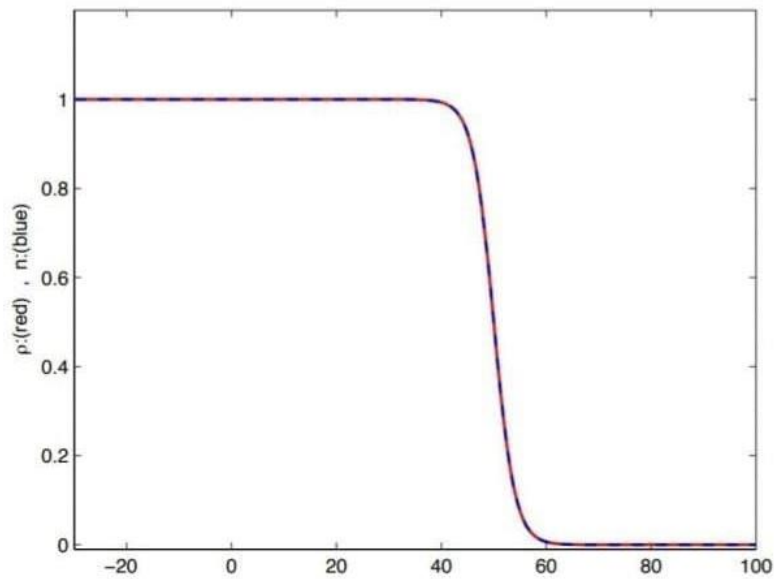


Fig (6) the initial condition of (6) p, n : (1 → 0) with parameter $\alpha = -2$, solution to the system (6) by using pdepe code in MATLAB.

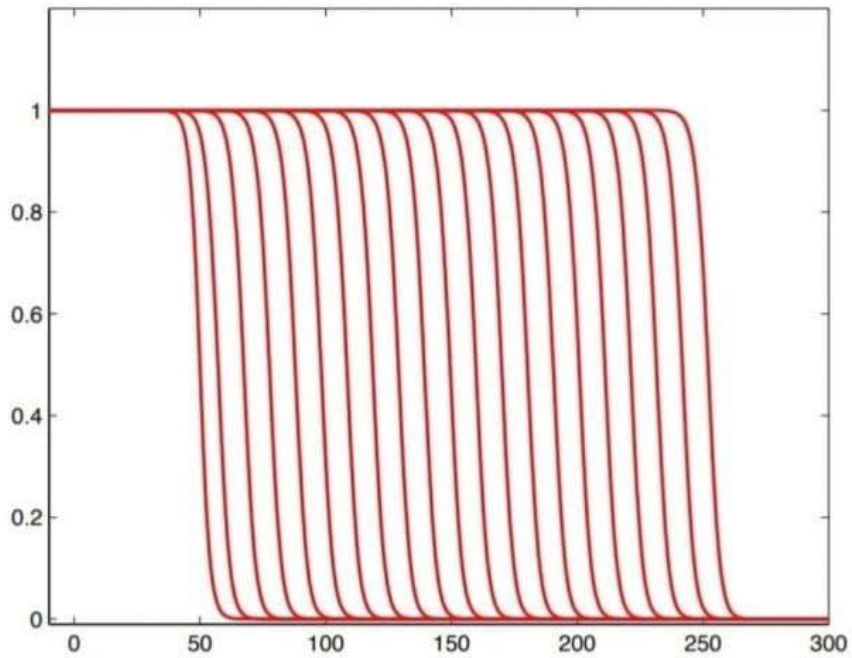


Fig (7) solution to the system (6) with parameter α , and the wave speed c . Take the value $\alpha = -2$ and $c = -0.79$ Solutions are produced using MATLAB pplane7.

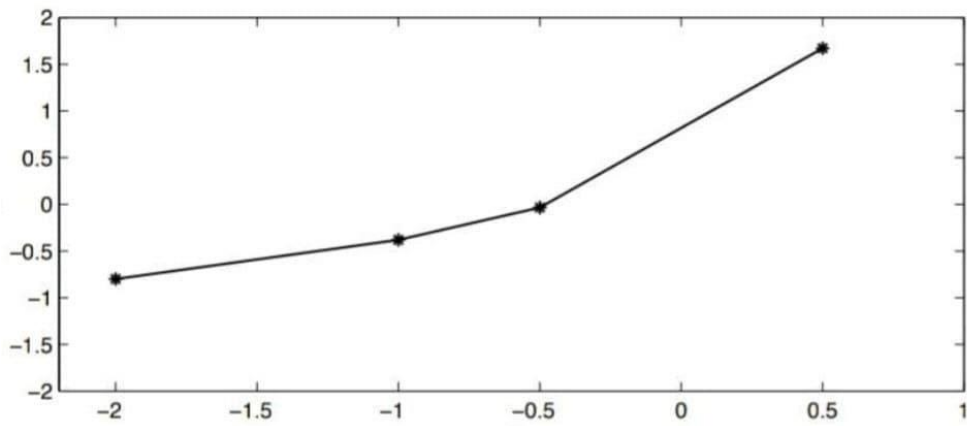


fig (8) Illustrates the relation between the value α , and waves speed c Solutions are produced using MATLAB pplane7.the figures above illustrate the relationship between the parameter α and traveling wave solution c , where the traveling wave solution c is increasing according to the increase the α . We can show that the following table:

α	-2	-1	-0.5
c	-0.79	-0.38	0.035

Table (2) Illustrate The Value Of A And C For Solution Of The Type Y X

From the data in the table above, we get a simple linear regression equation $c = 0.24 + 0.53\alpha$.

7. Conclusions

Through above results, Fig (8) We conclude that the travelling wave c increase whenever the values of α increase for time t. Also, we known the value of $\alpha = \frac{\alpha_1}{\gamma}$ and We observe that is directly proportional to α_1 (the number of tips produced per unit time) and inversely proportional to γ . (The rate constant for the hyphal autolysis). That is, from a biological standpoint, growth increases whenever increases

REFERENCES

- [1] Ali Hussein Shuaa-Taie.continuum models for fungal growth..phD thesis,university of Dundee,2011.
- [2] Alder,Michael."An introduction to mathematical modelling".,Heavenfor books.com(2001).
- [3] Anastasios tsoularis and James wallace. eigenvalue and eigenvector.,Mathematical bio sciences,179(1):21-55,2002
- [4] Andest,James Njida.some type of mathematical model of fungi.,Intermation Referred Journal of Engineering and science2.6(2013):01-03.
- [5] ,Brian Ingalls Mathematical Modeling in Systems Biology.,(2012).
- [6] Daniel Lawson,and Glenn Marion The Goals of Modeling., Bioinformatics and statistics Scotland (2008):3-13
- [7] Davidson, F. A. and Olsson, S .Translocation induced outgrowth of fungi in nutrient - free environment. J. theor. Biol. . 205:73–84.(2000)
- [8] Zhandg, Wei-Bin,ed type of mathematical models ,(2010).
- [9] ,singh, Ashok kumar, ed.Advanced x-ray tech.
- [10] Mudhafar Habeeb Zmakh ALQaraghuli.Fishers Equation.,PhD thesis, Ministry of High Education.(2013)
- [11] Mehrer,H.diffusion in solid: Fundamentals, methods, materials, diffusion controlled processes. Springer(2007)
- [12] Marion,Glenn,and Daniel Lawson."An introduction to mathematical modlling."Edin burgh:Bioinformatics and Statistics Scotland,University of Bristol.(2008)
- [13] Meyer,Walter J.concepts of Mathematical Modelling..Courior corporation,2012.
- [14] Odell,G.Mathematical Models in Cellular and Molecular and Molecular Biol ogy..(1980) pp.523-67
- [15] Healthcare..Multidisciplinary Digital Publishing Institute,(2017).
- [16] Farre, Albert, and Tim Rapley. "The new old (and old new) medical model: four decades navigating the biomedical and psychosocial understandings of health and illness.", Healthcare..Multidisciplinary Digital Publishing Institute,(2017).
- [17] philip k Hotchkiss and John Meier.The growth of trees.,The College Mathe matics Journal,35(2):143-151,2004
- [18] Ronaid W Shonkwiler and James Herod.Mathematical biology:an introduction with maple and matlab..Springer science&Business Media,2009