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# MATHEMATICAL MODELING FOR THE CONTROL AND MANAGEMENT OF NORTHERN CORN LEAF BLIGHT IN MAIZE WITH EARLY CHEMICAL SPRAY ON MAIZE PLANT

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## ABSTRACT

Northern Corn Leaf Blight, incited by the fungal pathogen exserohilum turcicum, poses a significant threat to maize production worldwide, necessitating innovative and sustainable control strategies. In this paper, a mathematical modeling for the control and management of northern corn leaf blight in maize with early chemical application. The model has been analyzed, in the local stability subsection, it has been shown that the disease-free equilibrium is locally asymptotically stable if the basic reproduction number is less than one. The global stability of disease-free equilibrium shows that; the system is globally asymptotically stable is the basic reproduction number is less than one. Further, we assess the global stability of endemic equilibrium point, which showed that the endemic equilibrium point is globally asymptotically stable if the basic reproduction number is greater than one. In numerical simulation section, we were able to assessed the impact of early chemical spray on maize plant and treating the infected maize plant with chemical spray, it has been noticed that, early chemical spray on maize plant is the best way to control the northern corn leaf blight in maize population. It is now recommended that early chemical spray on maize plant is the best way to control the northern corn leaf blight in maize.

**Keywords:** Mathematical Modeling, Leaf Blight, Maize, Plant, Chemical Spray

## INTRODUCTION

Maize (*Zea mays* L.) is one of the world's most important staple crops, serving as a critical source of food, feed, and industrial raw material. However, its production is significantly threatened by a range of biotic stressors, among which Northern Corn Leaf Blight (NCLB)—caused by the fungus *Exserohilum turcicum* is a major foliar disease leading to substantial yield losses, especially under favorable weather conditions like high humidity and moderate temperatures (Munkvold & White, 2016).

Traditional NCLB management strategies rely heavily on cultural practices (e.g., crop rotation, residue management), the deployment of resistant maize cultivars, and fungicide applications (Wise et al., 2009). While these methods have shown varying levels of success, they are often reactive and lack the precision needed for sustainable, cost-effective disease control under dynamic environmental conditions.

In recent years, mathematical modeling has emerged as a powerful tool in plant epidemiology, enabling researchers and practitioners to understand disease dynamics, predict outbreaks, and design optimal control strategies (Madden et al., 2007). Models—particularly compartmental systems such as the Susceptible-Exposed-Infected-Removed (SEIR) frameworks—are widely used to describe disease progression in crop populations. These models can incorporate critical biological parameters (e.g., latent periods, infection rates), agronomic practices (e.g., spacing, planting time), and environmental variables (e.g., rainfall, temperature), thereby capturing the multifactorial nature of plant disease epidemics (Jeger, 2004).

In addition to modeling disease spread, the integration of optimal control theory allows for the development of strategies that balance disease suppression with economic costs. By treating interventions such as fungicide use or resistant seed adoption as control variables, optimal control models provide a framework to minimize both the disease burden and the financial or environmental cost of interventions (Lenhart & Workman, 2007). These tools are especially valuable in precision agriculture, where decision-support systems can help optimize input use and improve sustainability.

Despite the critical importance of NCLB, relatively few studies have developed tailored mathematical models for its control. Most existing work either lacks specificity to *E. turcicum* or does not fully early chemical spray on maize plant. This research aims to address this gap by formulating a disease-specific mathematical model for NCLB that incorporates both epidemiological dynamics and early chemical spray on maize plant, ultimately contributing to more efficient and sustainable maize production systems.

## MATERIALS AND METHODS

### Model Formulation

The plant population N is sub-divided into four compartments, the Susceptible plants (S)
Exposed (latent) plants (E), Infected (I), and Recovered/resistant plants (R).

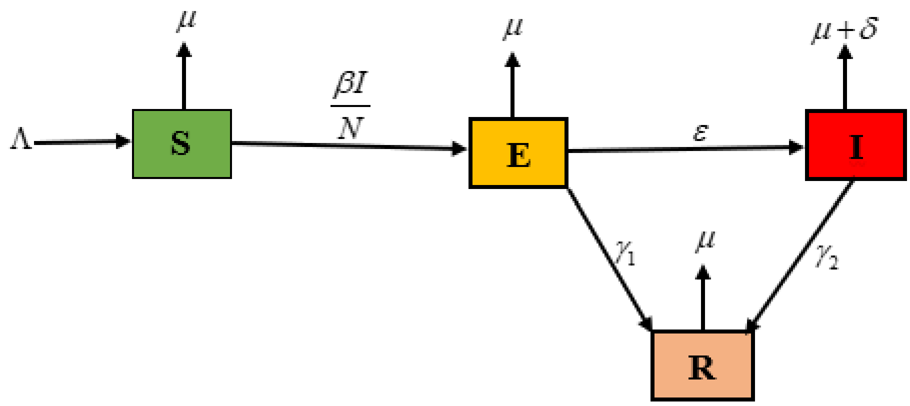



Figure 1: Schematized diagram of northern corn leaf blight

The susceptible plants (S) are generated at rate of recruitment $\Lambda$. The compartment reduces due to the association of infected plant with susceptible plant at the rate $\frac{\beta I}{N}$, where $\beta$ is the infection rate. The exposed (latent) plants (E) are generated due to the association of infected plant with susceptible plant at the rate $\frac{\beta I}{N}$, where $\beta$ is the infection rate. The compartment diminishes due to progression of latent at the rate $\varepsilon$ and early recovery due to chemical application at the rate $\gamma_1$. The infected compartment (I) is generated due to due to progression of latent at the rate $\varepsilon$. The compartment diminishes due to spore decay due to disease at the rate $\delta$ and recovery due to chemical application at the rate $\gamma_2$. The recovered/resistant plants (R) is generated due to the early recovery due to chemical application at the rate $\gamma_1$ and recovery due to chemical application at the rate $\gamma_2$. All the classes diminish due to spore decay $\mu$. The above assumption and explanation result to the following equation.

$$\frac{dS}{dt} = \Lambda - \frac{\beta IS}{N} - \mu S,$$
$$\frac{dE}{dt} = \frac{\beta IS}{N} - (\varepsilon + \gamma_1 + \mu)E,$$
$$\frac{dI}{dt} = \varepsilon E - (\delta + \gamma_2 + \mu)I, \quad (1)$$
$$\frac{dR}{dt} = \gamma_1 E + \gamma_2 I - \mu R$$

**Model Analysis**

In this section, the analytical analysis of the model will be ascertained

***Boundedness and Positivity of Solutions***

*Boundedness of solution*

Consider the region

$$\Omega = \left\{ \begin{pmatrix} S \\ E \\ I \\ R \end{pmatrix} \in \mathbb{R}_+^4 \left| \begin{matrix} S \geq 0 \\ E \geq 0 \\ I \geq 0 \\ R \geq 0 \end{matrix} \right. \right\} \quad (2)$$

It can be shown that the set $\Omega$ is positively invariant and a global attractor of all positive solution of the system (1).

***Lemma 1:*** The region $\Omega$ is positively invariant for the system (1).

Proof: The rate of change of the total human population is given as

$$\frac{dN}{dt} = \frac{dS}{dt} + \frac{dE}{dt} + \frac{dI}{dt} + \frac{dR}{dt} \quad (3)$$

substituting (1) in (3), gives

$$\frac{dN}{dt} = \Lambda - \mu N - \delta I \quad (4)$$

by standard comparison theorem,

$$\frac{dN}{dt} \leq \Lambda - \mu N \quad (5)$$

so, we have

$$\frac{dN}{dt} + \mu N \leq \Lambda \quad (6)$$

using the integrating factor method, we have

$$\frac{dN}{dt} e^{\mu t} + \mu N e^{\mu t} \leq \Lambda e^{\mu t} \quad (7)$$

simplifying (7), we have

$$\frac{d}{dt}(N e^{\mu t}) \leq \Lambda e^{\mu t} \quad (8)$$

taking the integral of (8), we have

$$\int \frac{d}{dt}\left(N e^{\mu t}\right) \leq \int \Lambda e^{\mu t} dt \quad (9)$$

integrating (3.38), gives

$$N e^{\mu t} \leq \frac{\Lambda}{\mu} e^{\mu t} + C \quad (10)$$

$$at\ t = 0,\ C = N(0) - \frac{\Lambda}{\mu} \quad (11)$$

substituting (11) into (10), we have

$$N e^{\mu t} \leq \frac{\Lambda}{\mu} e^{\mu t} + N(0) - \frac{\Lambda}{\mu} \quad (12)$$

simplifying (12), we have

$$N = N(0) e^{-\mu t} + \frac{\Lambda}{\mu}[1 - e^{-\mu t}] \quad (13)$$

If $N(0) \leq \frac{\Lambda}{\mu}$ then $N \leq \frac{\Lambda}{\mu}$ so, $\Omega$ is a positively invariant set under the flow described in (1). Hence, no solution path leaves through and boundary of $\Omega$. Also, since solution paths cannot leave $\Omega$, solutions remain non-negative for non-negative initial conditions. Solutions exist for all time $t$. In this region, the model (1) is said to be well posed mathematically and epidemiologically.

***Positivity of Solution***

***Lemma 2.*** Let the initial data for the model (1) be $S(0) > 0$, $E(0) > 0, I(0) > 0, R(0) > 0$, with positive initial data will remain positive for all time $t > 0$

Proof: Let $t_1 = \{t > 0 : S(0) > 0,\ E(0) > 0, , I(0) > 0,\ R(0) > 0\} > 0$

Simplifying the first model equation of model (1), we have

$$\frac{dS}{dt} = \Lambda - (\lambda + \mu)S \quad (14)$$

Where $\lambda = \frac{\beta I}{N}$, using the integrating factor method

$$I.F = exp\left[\mu t + \left\{\int_0^t (\lambda(\tau) + \mu) d(\tau)\right\}\right] \quad (15)$$

Applying (15) on (14), we have

$$\frac{d}{dt}\left[S(t) exp\left\{\mu t + \int_0^t (\lambda(\tau) + \mu) d(\tau)\right\}\right]$$
$$= \Lambda\left[exp\left\{\mu t + \int_0^t (\lambda(\tau) + \mu) d(\tau)\right\}\right] \quad (16)$$

integrating (16), gives

$$S(t_1) exp\left\{\mu t_1 + \int_0^{t_1} (\lambda(\tau) + \mu) d(\tau)\right\}$$
$$= S(0) + \int_0^{t_1} \Lambda\left[exp\{\mu y + \int_0^y (\lambda(\tau) + \mu) d(\tau)\}\right] dy \quad (17)$$

simplifying (17), we have

$S(t_1) = S(0)exp\left\{-\mu t_1 - \int_0^{t_1} (\lambda(\tau)+\mu)d(\tau)\right\} + \left[exp\left\{-\mu t_1 - \int_0^{t_1} (\lambda(\tau)+\mu)d(\tau)\right\}\right]\int_0^{t_1} \Lambda\left[exp\{\mu y + \int_0^{y} (\lambda(\tau)+\mu)d(\tau)\}\right]dy > 0$ (18)

for

$\frac{dE}{dt} = \lambda S - (\varepsilon+\gamma_1+\mu)E$ (19)

we have that

$\frac{dE}{dt} \geq -(\varepsilon+\gamma_1+\mu)E$ (20)

for

$\frac{dI}{dt} = \varepsilon E - (\delta+\gamma_2+\mu)I$ (21)

we have that

$\frac{dI}{dt} \geq -(\delta+\gamma_2+\mu)I$ (22)

for

$\frac{dR}{dt} = \gamma_1 E + \gamma_2 I - \mu R$ (23)

we have that

$\frac{dR}{dt} \geq -\mu R$ (24)

Similarly, we can also show that,

$S(t) > 0, e(t) > 0,\ I(t) > 0,\ R(t) > 0$ (25)

Hence Lemma 2 is proved.

***Disease free equilibrium***

The disease-free equilibrium can be solved when there bis no association between the susceptible plant and infected plant.

$\Omega^0 = (S^0, E^0, I^0, R^0) = \left(\frac{\Lambda}{\mu}, 0,0,0\right)$

***Basic reproduction***

In this subsection, we will compute the basic reproduction number, using spectral radius. Let F be a matrix of newly infected and V be a matrix of remaining transition elements.

$F = \begin{pmatrix} 0 & \beta \\ 0 & 0 \end{pmatrix}$ (26)

and

$V = \begin{pmatrix} \varepsilon+\gamma_1+\mu & 0 \\ -\varepsilon & \delta+\gamma_2+\mu \end{pmatrix}$ (27)

then,

$V^{-1} = \begin{pmatrix} \frac{1}{\varepsilon+\gamma_1+\mu} & 0 \\ \frac{\varepsilon}{(\varepsilon+\gamma_1+\mu)(\delta+\gamma_2+\mu)} & \frac{1}{\delta+\gamma_2+\mu} \end{pmatrix}$ (28)

the $FV^{-1}$ matrix can be given as

$FV^{-1} = \begin{pmatrix} \frac{\beta\varepsilon}{(\varepsilon+\gamma_1+\mu)(\delta+\gamma_2+\mu)} & \frac{1}{\delta+\gamma_2+\mu} \\ 0 & 0 \end{pmatrix}$ (29)

The basic reproduction number of system (1), can be given as

$R_0 = \frac{\beta\varepsilon}{(\varepsilon+\gamma_1+\mu)(\delta+\gamma_2+\mu)}$ (30)

***Local stability of disease-free equilibrium***

In this subsection, we analyzed the local stability of disease-free equilibrium point using Jacobian matrix, with the result of eigen-values of the Jacobian matrix.

***Theorem 1***: *System (1) is locally asymptotically stable if all the eigen-values of the system is less than zero while* $R_0 < 1$.

Proof: Let J be the Jacobian matrix of system (1), evaluate at disease-free equilibrium

$J(\Omega^0) = \begin{bmatrix} -\mu & 0 & -\beta & 0 \\ 0 & -(\varepsilon+\gamma_1+\mu) & \beta & 0 \\ 0 & \varepsilon & -(\delta+\gamma_2+\mu) & 0 \\ 0 & \gamma_1 & \gamma_2 & -\mu \end{bmatrix}$ (31)

we used maple software to get upper triangular matrix below

$\begin{bmatrix} -\mu & 0 & -\beta & 0 \\ 0 & -(\varepsilon+\gamma_1+\mu) & \beta & 0 \\ 0 & 0 & \frac{-(\varepsilon+\gamma_1+\mu)(\delta+\gamma_2+\mu)+\varepsilon\beta}{(\varepsilon+\gamma_1+\mu)} & 0 \\ 0 & 0 & 0 & -\mu \end{bmatrix}$ (32)

then, the eigen-values are given by

$\begin{bmatrix} \lambda_1 = -\mu \\ \lambda_2 = -(\varepsilon+\gamma_1+\mu) \\ \lambda_3 = -\frac{(\varepsilon+\gamma_1+\mu)(\delta+\gamma_2+\mu)-\varepsilon\beta}{(\varepsilon+\gamma_1+\mu)} \\ \lambda_4 = -\mu \end{bmatrix}$ (33)

all the eigen-values are less than zero except $\lambda_3$, simplifying $\lambda_3$, we have

$\lambda_3 = -\frac{(\varepsilon+\gamma_1+\mu)(\delta+\gamma_2+\mu)-\varepsilon\beta}{(\varepsilon+\gamma_1+\mu)} = (\delta+\gamma_2+\mu)\left[\frac{\varepsilon\beta}{(\varepsilon+\gamma_1+\mu)(\delta+\gamma_2+\mu)} - 1\right] = (\delta+\gamma_2+\mu)[R_0 - 1]$ (34)

Therefore, we conclude that the system is locally asymptotically stable if the basic reproduction number is less than one.

***Global stability of disease-free equilibrium***

In this subsection, we will use linear Lyapunov function to prove the global stability of disease-free equilibrium.

***Theorem 2:*** *The disease-free equilibrium of system (1) is globally asymptotically stable if* $R_0 < 0$.

Proof: Let V be a linear Lyapunov function

$V = A_1 E + A_2 I$ (35)

differentiating equation (35), we obtained

$\dot{V} = A_1\dot{E} + A_2\dot{I}$ (36)

substituting the values of the concerned derivatives in (1), we have

$\dot{V} = A_1\left(\frac{\beta IS}{N} - (\delta+\gamma_2+\mu)E\right) + A_2(\varepsilon E - (\delta+\gamma_2+\mu)I)$ (37)

expanding equation (37) and rearrange, we obtain

$\dot{V} = A_1\frac{\beta IS}{N} - [(\varepsilon+\gamma_1+\mu)A_1 - \varepsilon A_2]E - A_2(\delta+\gamma_2+\mu)I$ (38)

this implies that

$A_1 = \varepsilon, A_2 = \varepsilon+\gamma_1+\mu$ (39)

substituting the values in equation (39) into equation (38), we have

$\dot{V} = \varepsilon\frac{\beta IS}{N} - (\varepsilon+\gamma_1+\mu)(\delta+\gamma_2+\mu)I$ (40)

at disease-free equilibrium, $S \leq S^0$ and $N \leq N^0$, equation (40), becomes

$\dot{V} \leq \varepsilon\beta I - (\varepsilon+\gamma_1+\mu)(\delta+\gamma_2+\mu)I$ (41)

Simplifying equation (41), we have

$\dot{V} \leq (\varepsilon+\gamma_1+\mu)(\delta+\gamma_2+\mu)\left[\frac{\varepsilon\beta}{(\varepsilon+\gamma_1+\mu)(\delta+\gamma_2+\mu)} - 1\right]I$

$\dot{V} \leq (\varepsilon+\gamma_1+\mu)(\delta+\gamma_2+\mu)[R_0 - 1]I$ (42)

Hence, we conclude using Lassalle's invariant principle, the disease free equilibrium is globally asymptotically stable if $\dot{V} \leq 0 and R_0 < 1$.

***Endemic equilibrium point***

Let $\Omega^{**}$ be an endemic equilibrium point, we solved equation (1) at endemic equilibrium point

$\Omega^{**} = \begin{pmatrix} S^{**} = \frac{\Lambda}{\lambda^{**}+\mu}, \\ E^{**} = \frac{\Lambda\lambda^{**}}{(\mu+\gamma_1+\varepsilon)(\lambda^{**}+\mu)}, \\ I^{**} = \frac{\varepsilon\Lambda\lambda^{**}}{(\mu+\gamma_2+\delta)(\mu+\gamma_1+\varepsilon)(\lambda^{**}+\mu)}, \\ R^{**} = \frac{\gamma_1\Lambda\lambda^{**}}{(\mu+\gamma_1+\varepsilon)(\lambda^{**}+\mu)\mu} + \frac{\gamma_2\varepsilon\Lambda\lambda^{**}}{(\mu+\gamma_2+\delta)(\mu+\gamma_1+\varepsilon)(\lambda^{**}+\mu)\mu}, \end{pmatrix}$ (43)

***Global stability of endemic equilibrium point***

This subsection addresses global stability of endemic equilibrium point using non-linear Lyapunov function of Goh-Volterra type.

***Theorem 3:*** *The endemic equilibrium point of system (1) is globally asymptotically stable if* $\gamma_1 = 0$ *and* $R_0 > 0$.

Proof: Let $F$ be a non-linear Lyapunov function

$$F = \left(S - S^{**} - S^{**}\ln\frac{S}{S^{**}}\right) + \left(E - E^{**} - E^{**}\ln\frac{E}{E^{**}}\right) + \frac{(\varepsilon+\gamma_1+\mu)}{\varepsilon}\left(I - I^{**} - I^{**}\ln\frac{I}{I^{**}}\right) + \frac{(\varepsilon+\gamma_1+\mu)(\delta+\gamma_2+\mu)}{\varepsilon\gamma_2}\left(R - R^{**} - R^{**}\ln\frac{R}{R^{**}}\right) \tag{44}$$

differentiating equation (44), we have

$$F = \left(\dot{S} - \frac{S^{**}}{S}\dot{S}\right) + \left(\dot{E} - \frac{E^{**}}{E}\dot{E}\right) + \frac{(\varepsilon+\gamma_1+\mu)}{\varepsilon}\left(\dot{I} - \frac{I^{**}}{I}\dot{I}\right) + \frac{(\varepsilon+\gamma_1+\mu)(\delta+\gamma_2+\mu)}{\varepsilon\gamma_2}\left(\dot{R} - \frac{R^{**}}{R}\dot{R}\right) \tag{45}$$

substituting system (1) into equation (45) with the condition that $\gamma_1 = 0$, we have

$$F = \left(\Lambda - \lambda S - \mu S - \frac{S^{**}}{S}(\Lambda - \lambda S - \mu S)\right) + \left(\lambda S - (\varepsilon+\mu)E - \frac{E^{**}}{E}(\lambda S - (\varepsilon+\mu)E)\right) + \frac{(\varepsilon+\gamma_1+\mu)}{\varepsilon}\left(\varepsilon E - (\delta+\gamma_2+\mu)I - \frac{I^{**}}{I}(\varepsilon E - (\delta+\gamma_2+\mu)I)\right) + \frac{(\varepsilon+\gamma_1+\mu)(\delta+\gamma_2+\mu)}{\varepsilon\gamma_2}\left(\gamma_2 I - \mu R - \frac{R^{**}}{R}(\gamma_2 I - \mu R)\right) \tag{46}$$

at endemic equilibrium point, we have

$$\Lambda = \lambda S^{**} + \mu S^{**}, \varepsilon + \mu = \frac{\lambda S^{**}}{E^{**}} \delta + \gamma_2 + \mu = \frac{\varepsilon E^{**}}{I^{**}}, \mu R^{**} = \gamma_2 I^{**} \tag{47}$$

substituting equation (47) into (46), we have

$$F \leq \mu S^{**}\left[2 - \frac{S}{S^{**}} - \frac{S^{**}}{S}\right] + \lambda S^{**}\left[5 - \frac{S^{**}}{S} - \frac{EI^{**}}{E^{**}I} - \frac{SE^{**}}{S^{**}E} - \frac{R}{R^{**}} - \frac{IR^{**}}{I^{**}R}\right] \tag{48}$$

using geometric mean to arithmetic relation, we have that

$$\left[2 - \frac{S}{S^{**}} - \frac{S^{**}}{S}\right] \leq 0, \left[5 - \frac{S^{**}}{S} - \frac{EI^{**}}{E^{**}I} - \frac{SE^{**}}{S^{**}E} - \frac{R}{R^{**}} - \frac{IR^{**}}{I^{**}R}\right] \leq 0 \tag{49}$$

Therefore, using Lassalle's invariant principle, we have that $F \leq 0$, hence, we conclude that endemic equilibrium points of system (1) is globally asymptotically stable.

**Numerical Simulation**

In this section, we simulated the compartments of model (1), assessing the impact of some control parameters on the compartment of the model, also, the parameters and their values are given in Table 1. The simulation has been done using ODE45 in MATLAB 14.

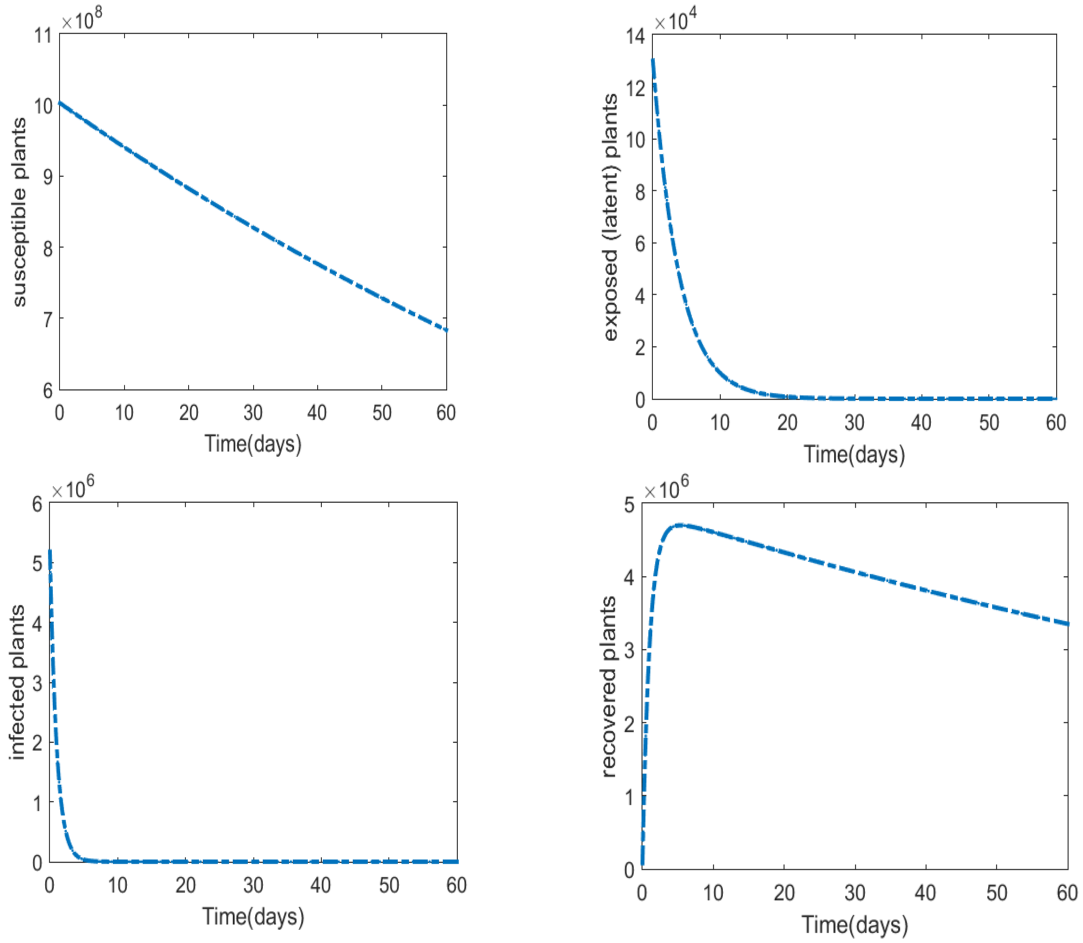



Figure 2: Figure shows the behavior of all the compartment of model (1)

Figure 2 shows the behavior of all the compartment of model (1), while the values of parameters in Table 1 are not varied.

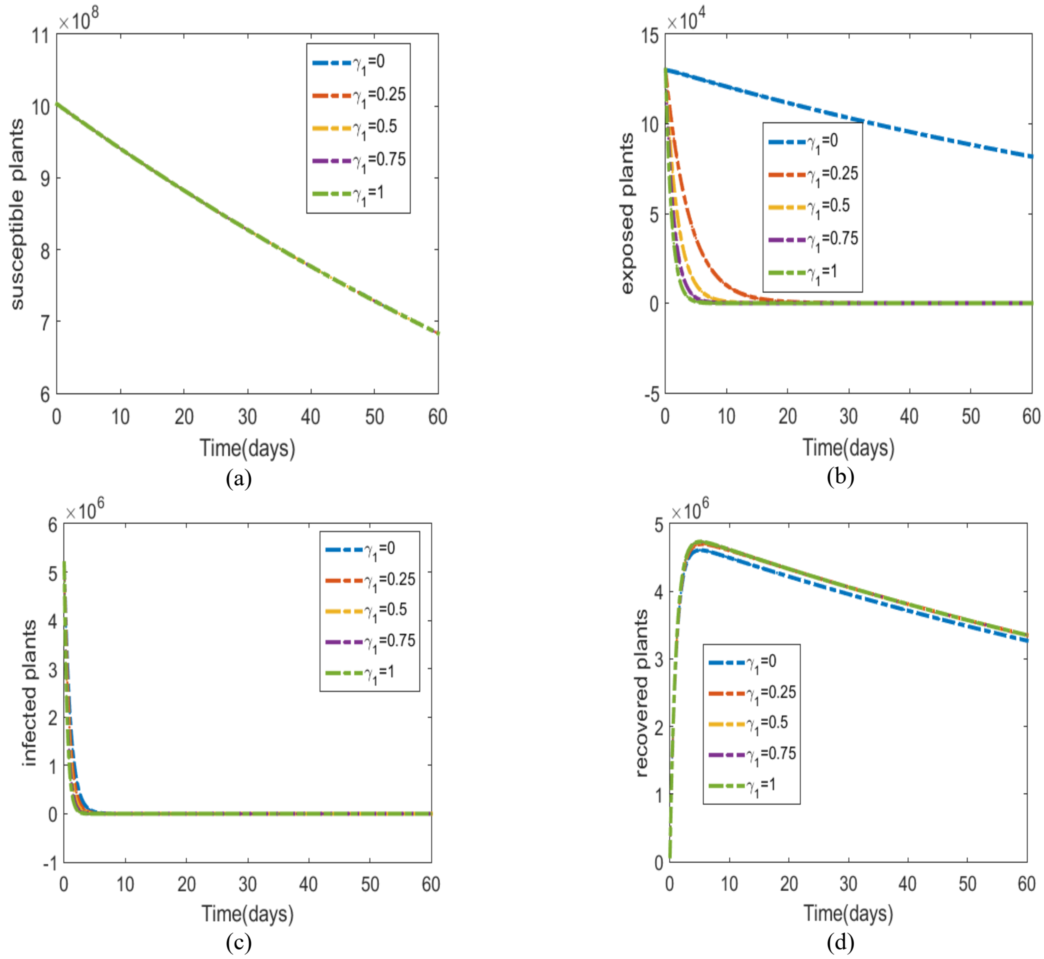
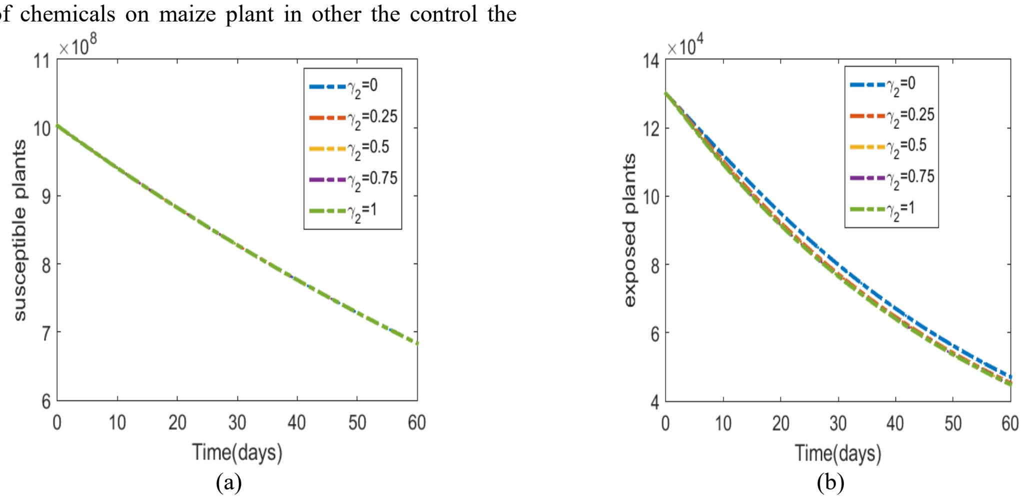
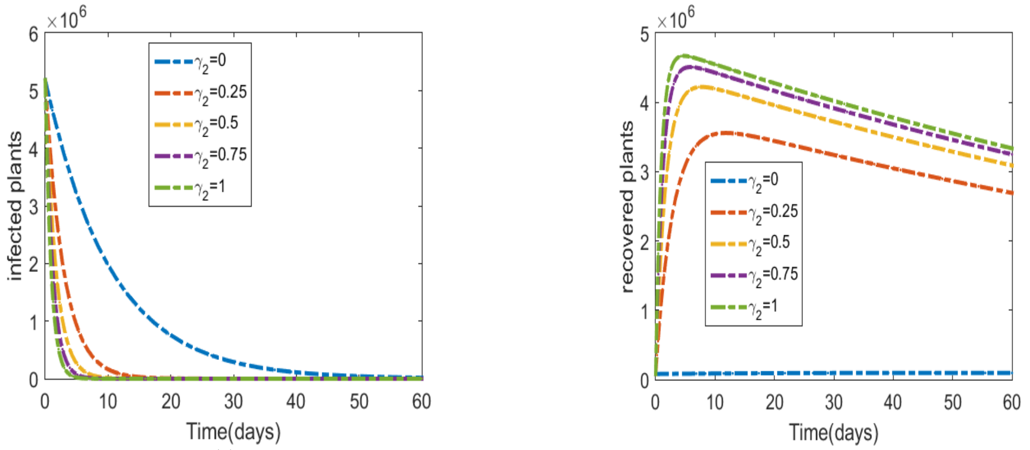



Figure 3: Figure showing the effect of early spray of chemicals spray on all the compartment of model (1) to control northern corn leaf blight in maize

Figure 3(a) shows the influence of early spray of chemicals on maize plant in other the control the northern corn leaf blight in maize population on susceptible maize plant, we seen that spraying chemicals does not affect the population of susceptible maize plant. Figure 3(b) shows the influence of early spray of chemicals on maize plant in other the control the northern corn leaf blight in maize population on exposed maize plant, we have seen from the above simulation that spraying chemicals affects the population of exposed maize plant, as we increased the control the exposed maize plant diminishes over time. Figure 3(c) shows the influence of early spray of chemicals on maize plant in other the control the northern corn leaf blight in maize population on infected maize plant, we have seen from the above simulation that spraying chemicals affects the population of infected maize plant, as we increased the control the infected maize plant diminishes over time a little. Figure 3(d) shows the influence of early spray of chemicals on maize plant in other the control the northern corn leaf blight in maize population on recovered maize plant, we have seen from the above simulation that spraying chemicals affects the population of recovered maize plant, as we increased the control the recovered maize plant increases over time.






(c) (d)

Figure 4: Figure showing the effect of spray of chemicals spray on all the compartment of model (1) to control northern corn leaf blight in maize

Figure 4(a) shows the influence of spray of chemicals on maize plant in other the control the northern corn leaf blight in maize population on susceptible maize plant, we've seen that spraying chemicals does not affect the population of susceptible maize plant. Figure 4(b) shows the influence of spray of chemicals on maize plant in other the control the northern corn leaf blight in maize population on exposed maize plant, we have seen from the above simulation that spraying chemicals affects the population of exposed maize plant, as we increased the control the exposed maize plant diminishes over time. Figure 4(c) shows the influence of spray of chemicals on maize plant in other the control the northern corn leaf blight in maize population on infected maize plant, we have seen from the above simulation that spraying chemicals affects the population of infected maize plant, as we increased the control the infected maize plant diminishes over time a drastically. Figure 4(d) shows the influence of spray of chemicals on maize plant in other the control the northern corn leaf blight in maize population on recovered maize plant, we have seen from the above simulation that spraying chemicals affects the population of recovered maize plant, as we increased the control the recovered maize plant increases over time.

## CONCLUSION

In this paper, a mathematical modeling for the control and management of northern corn leaf blight in maize with early chemical application. The model has been analyzed, in the local stability subsection, it has been shown that the disease-free equilibrium is locally asymptotically stable if the basic reproduction number is less than one. The global stability of disease-free equilibrium shows that; the system is globally asymptotically stable is the basic reproduction number is less than one. Further, we assess the global stability of endemic equilibrium point, which showed that the endemic equilibrium point is globally asymptotically stable if the basic reproduction number is greater than one. In numerical simulation section, we were able to assessed the impact of early chemical spray on maize plant and treating the infected maize plant with chemical spray, it has been noticed that, early chemical spray on maize plant is the best way to control the northern corn leaf blight in maize population. It is now recommended that early chemical spray on maize plant is the best way to control the northern corn leaf blight in maize.

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