



HAL
open science

Biological control of diamondback moth: a mathematical approach

Aurelien Kambeu Youmbi, Suzanne Touzeau, Frédéric Grognard, Berge Tsanou

► To cite this version:

Aurelien Kambeu Youmbi, Suzanne Touzeau, Frédéric Grognard, Berge Tsanou. Biological control of diamondback moth: a mathematical approach. DSABNS 2024 - 15th International Conference on Dynamical Systems Applied to Biology and Natural Sciences, Feb 2024, Caparica, Portugal. hal-04452042

HAL Id: hal-04452042

<https://hal.inrae.fr/hal-04452042v1>

Submitted on 12 Feb 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution 4.0 International License

BIOLOGICAL CONTROL OF DIAMONDBACK MOTH: A MATHEMATICAL APPROACH.

Aurelien Kambeu Youmbi^{*1,3}, Suzanne Touzeau^{2,3}, Frédéric Grognard² and Berge Tsanou^{1,4}

¹University of Dschang, URMA, Cameroon

²Université Côte d'Azur, INRIA, INRAE, CNRS, MACBES, France

³Université Côte d'Azur, INRAE, ISA, France

⁴University of Pretoria, South Africa

aurelienkambeu@gmail.com (*presenter)

suzanne.touzeau@inrae.fr, frederic.grognard@inria.fr, bergetsanou@gmail.com

Cabbage is one of the most important vegetables grown in the world. Pest activities result in the loss of a significant amount of its production. The most important of these is the diamondback moth. Several techniques have been developed to limit the damage caused by this pest, such as parasitoid-based biological control. In this work, we build a nonlinear model using ordinary differential equations by considering the biomass of cabbage in the field, the diamondback moth larvae population, and the larval parasitoid population. The growth of parasitoids on larvae is modeled using the Beddington-DeAngelis type functional response characterized by mutual interference of parasitoid β and pest resistance to predation α . In the first study, we assume that a quantity of parasitoids is introduced into the farm. We show that the best strategy to achieve permanent establishment and sustainable control is to use parasitoids with a long life cycle. In the second study, we assume that the parasitoids are released continuously in the plantation. We show that solitary parasitoids have a better control effect than gregarious parasitoids because of their β low values. Thus, with parasitoids with low mutual interference, we compute a critical release value which represents the minimum rate of parasitoids to be introduced to obtain and maintain a healthy plantation. In addition, the system presents either a transcritical bifurcation or a backward bifurcation depending on the values of parameter α . Hence, this study provides both qualitative and quantitative foundations for the implementation of parasitoid-based biological control techniques.