Thursday, July 26th, 14:00 Room: C8.2.03

MINISYMPOSIUM

MATHEMATICAL MODELS FOR PEST CONTROL

Organizer
Andrea Pugliese
Trento University Italy
andrea.pugliese@unitn.it

Co-organizer
Bedreddine Ainseba
Bordeaux University France
bedreddine.ainseba@u-bordeaux.fr

Minisymposium Keywords: Population dynamics, Pests modelling, Biological control, Integrated pest management (IPM).

The aim of the minisymposium is to present to a wider audience an overview of recent progress made in the use of mathematical models in the field of pest control in agriculture, and to allow an exchange among researchers on the challenges to be addressed. Topics covered may include (but are not limited to) environmentally-driven models to predict potential damage; biological control through pathogens or parasitoids; IPM by using landscape diversity and/or resistant plants; sustainable food security.

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ARE WE ABLE TO PREDICT PEST DYNAMICS?

Bedreddine Ainseba

bedreddine.ainseba@u-bordeaux.fr

Bordeaux University, 351 Cours de la Liberation, Bordeaux, France

Joint work with Delphine Picart (INRA Bordeaux), Denis Thiery (INRA Bordeaux)

Keywords: Pest modelling, Partial differential equations, Cumulated temperature.

In this talk we consider two type of pests that make many damages in the south west of France. The first one, Loebesia-Botrana has many cycles per year and causes big damages in the vineyards. The second one, Chest nut Carpocapse, has one cycle per year and makes damages in the chestnut production. We build a specific mathematical model describing the growth of each pest population using field and laboratory data from the south west of France. These models consists on a set of first order partial differential equations with non constant velocities depending on the accumulated temperature by the pest. Identifiability of the hatching rate will be discussed on the light of the possible experimental data. We will also discuss some questions in connexion with controllability of this type of structured systems.

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A POPULATION DYNAMICS MODEL AS TOOL FOR PEST CONTROL IN VINEYARDS

Sara Pasquali

sara.pasquali@mi.imati.cnr.it

CNR-IMATI, Via Bassini, 15 20133 Milano, ITALY

Joint work with Gianni Gilioli (Brescia university, Italy), Enrico Marchesini (AGREA S.r.l. Centro Studi Via Garibaldi, San Giovanni Lupatoto (VR), Italy)

Keywords: Integrated pest management, Stage structured population model, Control.

Integrated pest management requires knowledge of the phenology and dynamics of the pests and the environmental variables influencing them. This allows to efficiently apply control methods able to reduce the impact of pests. The sustainable use of pesticides to control pests has been regulated by the European Directive 2009/128/EC that aims to reduce environmental and health impact, and to increase product quality. Population dynamics models are important tools to support decision making for prevention and pest control. We introduce a demographic model for stage structured populations based on a system of Fokker-Planck partial differential equations considering a set of biodemographic functions (development, mortality and fecundity rate functions) depending on environmental variables. This model is general and can be used for all the insect pests once the biodemographic functions have been estimated taking into account the biology of the species under study. Here we refer to the main insect pest in European vineyards, the grape berry moth. This moth has four biological stages, and larvae are responsible of damages to the grape bunches. Development and fecundity are estimated using literature data on the biology of the species, while mortality is estimated applying statistical methods, starting from population abundance data collected in a vineyard situated in Colognola ai Colli (Verona, Northern Italy) for the years 2008-2013. The grape berry moth has three or four generations per year. The larvae of the second generation are the most damaging, therefore they are considered the main target for pest control. The model provides pest phenology and population abundance in each stage for each generation as function of the environmental temperature and host plant phenology. It then represents a suitable tool to support decision making for pest control.

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A MATHEMATICAL MODEL OF ARMYWORM DYNAMICS AND CONTROL USING A BIOLOGICAL CONTROL AGENT

Rachel Norman

rachel.norman@stir.ac.uk

University of Stirling, United Kingdom

Keywords: Africa armyworm, Seasonal mathematical model, Biological control.

The Africa armyworm, Spodoptera exempta (Lepidoptera: Noctuidae) is a pest of cereal crops in Africa. It is capable of destroying entire crops in a matter of weeks. Its population grows in response to the rainy season and it is wind dispersed across the continent. There are a number of possible control strategies for these pests, they include spraying of chemicals e.g. cypermethrin but there is also the possibility of biological control using a virus which naturally infects the African armyworm. In this talk we will present a mathematical model of the seasonal and dynamics of the armyworm, its natural relationship with the virus and then how we might use this virus as a control agent.

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THE INFLUENCE OF LANDSCAPE DIVERSITY ON INSECT-PEST DISPERSAL AND ESTABLISHMENT

Claudia Pio Ferreira

pio@ibb.unesp.br

IBB, UNESP, Brazil

Keywords: Diabrotica speciosa, Stochastic cellular automata, Effects of landscape structure.

The effects of landscape structure on species with resource nutritional partition between immature and adult stages is assesed by investigating how food quality and spatial structure affect the invasion and colonization of the insect pest, Diabrotica speciosa. To this end, a bidimensional stochastic cellular automata was formulated. Each automata site has a specific culture type, which can affect differently the fitness attributes of immatures and adults, such as mortality, development and oviposition rates. We derived the mean-field approximation for theis automata model, from which we obtained conditions for insect invasion. Using artificially generated landscapes, we discussed how the structured heterogeneous landscape can affect dispersal and establishment of insect populations. Habitat manipulation as a strategy for regulating natural population densities of Diabrotia speciosa suggested that intercropping corn with other crop system reduced inset spread through landscape. Spatiotemporal patterns obtained by simulations shown that the availability of corn border at field edge is key for insect population control. A sensitivity analysis indicated that the main parameters that influence population density and dispersion speed are insect oviposition rate and development rate. Preliminary results in a nonstatic landscape is discussed.