NUMERIC SIMULATION SYSTEM USING ARTIFICIAL INTELLIGENCE TO ANALYZE THE COTTON BOLL WEEVIL DYNAMIC POPULATION

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ABSTRACT

The cotton boll weevil is an insect that has its life cycle very close with the cotton culture. Its preferences for the structures of frutifications (squares and bolls), used as feed and reproducing sites, imposes a great number of damages on culture. In this sense, founded at certain levels of population, this insect becomes a serious cotton pest, needing immediactive intervention for culture productivity security. Following the orientations of the Integrated Pest Management Program, it's possible to determine when the insect population reachs hazards levels to the culture and to decrease the number of pesticides applications needs to the pest control. In the Brazilian environment there are a great number of promising natural enemies to be used as biological control agents. But it is very difficult to determine the number of these populations and when to liberate them on the crop, able to secure an efficient pest control.

The main objective of this work was to develop a simulation system in order to monitor the populational dynamics of the cotton boll weevil *(Anthonomus grandis Boheman, Coleoptera:Curculionidae)* at different levels of infestation, interacting the numeric simulation and artificial intelligence techniques. The source program was developed in C language, in a SUN Sparc Station UNIX-OS, sponsored by DOD-EMBRAPA's PhD- Programme, in DENSIS-FEE/UNICAMP (PESSOA, 1994). The program has a modular structure, allowing the inclusion of new modules, as well as modifications in the existing modules to incorporate particular situations of regions that will be studied, without compressing the program structure.

2- DISCUSSION

The insect-plant-physical environment found in Campinas region was simulated using average data collected on cotton crops subjected to Integrated Pest Management Programs (IPM), determining the critical periods where the pest can reach the Economic Threshold and the Economic Damage Level. The main system has the biotic factors represented by three dynamics cohort mathematical models. Each model contains detailed information about the biological components. plant, cotton boll weevil and parasitoid. Physical environmental factors also have been contemplated in the main system, using daily maximum and minimum temperatures, applied to the Thermal Constant Concept, and daily rain, in millimeters, that can be generated randomly.

Coupled to the main system there is an expert system responsible for deciding the convenience of the use of pesticides, oriented by IPM. The questions needed to feed the inference mechanism of the expert system are answered by the main system, that continues the simulation process without breaks (feed-back).

The system allows users to work on different infestation scenarios, with or without the parasitoid population influencing, the cotton boll weevil larval mortality. When users stipulate a date for the occurrence of the liberation of the *Bracon vulgaris* population, the biological control is assumed as the control form

of analysis, and the expert system turns off the use of chemical control, although the thresholds can be reached, in order to permit only the analysis of the parasitism influence in the pest control. The input data can be done by keyboard or datafile previously typed by the user. This second type of input data is very useful when users want analyze different dates of Bracon population liberations with the same initial infestation inputs. The number of days for simulation is specified by the user. The program computes the losses of cotton plant frutification structures caused by natural factors and pest presence. The different pest mortality factors are also computed in distinguished formats (parasites, pesticide, natural death, immature development phase deaths). The different immature phases of cotton boll weevil that had been occurring in the squares and bolls are isolately computed in order to give the users the idea of the pest adults that will emerge from the squares and bolls, respectively. The program has a random generator of temperature (in °C) and pluviosity (mm) for the Campinas region, SP, that can be used by users if desired. Squares and bolls are considered differently, having differents "instars" within those stages according to their dry-weights, allowing preferential attacks of the pest according to the availability of the frutifications structures.

The output data of the program are stored in files, making it easy for users to build graphs and reports. Reports can be shown on descriptive or table formats, for daily, 3-day or weekly periods, according to the user's preference.

3- RESULTS

It was simulated five scenaries: one without control, one without parasitoid (controlled by pesticides applications governed by IPM) and three with parasitoid without pesticides uses. All of scenaries have the same base scenery: date of planting, structures attached by cotton boll weevil and cotton boll weevil population. The scenaries with the parasitoid had different dates and quantities of liberation. It was seen by simulations that: - it's impossible to have an economic productivity of cotton crop, on the presence of cotton boll weevil, without any type of control of its population; - Out of

the periods of planting, established by the IPM in Campinas region, a great number of cotton losses are caused by rain. At these periods, rain caused more losses than cotton boll weevil; - It's more important the convenient choice of date to liberate the parasitoid than a big population of them. Simulations shows that the natural population of *Bracon vulgaris* founded in Campinas region aren't enought for the cotton boll weevil control. However, an increase in this population gave good results. The same number of parasitoid populations liberated in field at deferent months gave deferent results on the cotton boll weevil control; - It's possible to have a good cotton productivity, using *Bracon vulgaris*. In this sense, would be good more studies on the survey of this parasitoid, potential as a future biological control agent of cotton boll weevil in Brazil.

PESSOA, M.C.P.Y. Simulação e inteligência artificial aplicadas ao estudo da dinâmica populacional do bicudo do algodoeiro em Campinas/SP. Campinas : UNICAMP, 1994. 340p. (PhD. Thesis Dissertation).

KEY WORDS:
boll weevil; cotton; parasitoid; IPM; simulation; expert system; populational dynamics