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A Computer System for Forecasting the Threshold Period for Crop Weed Control

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Abstract

In this article, a model of a weed control threshold forecast system has been established, with related model solving, data checking, database setting up, and system engineering illustration. Moreover, it is tested by a software with data from a sugar cane planting experimental field in Yunnan, China. The methodology behind the detailed system analysis, design, and engineering has been discussed. The issue of how to create a dynamic data-dependent forecast model of a threshold forecast system, whose threshold changes according to the change of planting environment has been solved. Hence an effective solution has been initiated for further development on an agricultural expert system.

Key words: weed control, threshold, forecast system

INTRODUCTION

All types of crop fields around the world generally have various weeds growing, causing great loss of crop product, or even having nothing to be reaped. Therefore, it is necessary to spend a great amount on weed control. It increases investment and affects agricultural production development. Therefore weed control becomes the main problem in the course of crop planting and proper selection of control threshold becomes the key to weed control.

A number of researches show that weeds in agricultural ecosystems are not only harmful to crops, but also useful (Jay and Joe 2001). Its harmful effects can be cited as follows: weed and crop fighting for fertilizer, water, sunlight, and other nutrients, resulting in the crops not being able to get sufficient nutrition when they need a great deal of nutrition, which eventually leads to a decrease in crop production. Its beneficial effects can be cited as: vegetal weeds in the early age of crop growth and tender weeds that appear in the middle or latter stage covering the soil, decreasing water, fertilizer, and soil losses, and increasing soil organic matter and soil system negative entropy, maintaining biodiversity, stabilizing the ecosystem, and so forth. Therefore, to maintain one period of crop growing, without grass, can exclude the negative impacts on crops from weeds as well as obtain the active effect of stabilizing the ecosystem. This period is called field weed control threshold (Mahajan *et al*. 2007).

As shown in Fig.1, in accordance with the effect of weeds on crop yield, S is the economic measuring line which is the crop loss rate acceptable by people in in-

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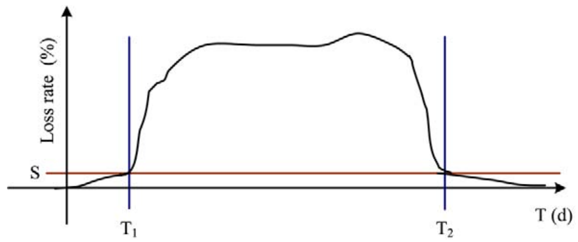

Fig. 1 Economic threshold of weed control.

dustry world. T_1 and T_2 are the points of intersection of weeds growth curve and S. Thus the interval (T_1, T_2) following the economic rules is called the economic control threshold. The positive effects of the weeds can be exerted on the field ecosystem because of control the field weed according to the weed economic control threshold, such as, reducing the quantity and frequency of weed killer use and protecting the field ecological environment.

Through researching a large number of domestic and foreign related materials, many reports on weed control threshold research can be seen. They not only cover a wide range of related research from the environment, climate, crop type, weed types, and density aspects, but also establish quite a large number of methods and models for the threshold of weed control (James and Sheltonand 1989; Ames 1996; Chandran and Wallbrown 2004; Andrea and Rebecca 2002). Generally speaking, weeds compete with crops in the fields by directly correlating with the quantity of weed occurrence. At home and abroad, researches give numerous reports on the relationship between weed density and crop yield loss quantity. A majority of these reports are based on the general primary function model, which describes the relationship between weed and crop yield, but crop yield loss rate reflected from some models tends to be infinite when weed density tends to be infinite. Which is resulting in that people can not forecast accurately, and the biology meaning of parameters in the models is ambiguous. In recent years, using the hyperbolic function model and the power exponent model, the competitive relationship between the weed and crop is described, and better explanation of the biological significance of the parameters is obtained.

Seen from the point of view of application, there are many researches, depending on the variety of factors that impact on the threshold forecast, and the correlation among these factors. Adopted mathematical models of these researches usually lack the basic derivation process and cite the experience model from the literature to study the threshold. We find that the main experiment data listed in some articles can inosculate themselves experience models, and satisfy significance test. However, they cannot satisfy the significance test for the data from other time intervals or those collected from other croplands. That is to say, the experience models from most of the articles do not have good repeatability or extensibility.

The main reason for this result is that the biological significance of the model parameters has been overlooked in most researches. Model parameters obtained from experience are only fit for a group of experiment data from a specific environment, and do not represent the whole experiment data. In fact, model parameters vary with experiment data obtained from different environments, that is to say, parameters should be dynamic. They vary with input data, and maybe this change is not too large, but it reflects in the change of crop growth environment. Therefore the conclusion of that threshold should be kept constant if crop and weed do not change from the former researchers is wrong.

According to experiment data input, dynamically calculating model parameters and establishing the system can satisfy the requirements of the threshold forecast repeatability and ensure the application extensibility of the system. To determine the conventional model parameters usually manual or programming methods are used, and it even does not establish a system database. Furthermore the computational complexity is very large. It is obvious that conventional methods cannot adapt to large-scale data processing and forecasting. It becomes a big problem in the threshold forecast system and the main problem needs to be solved here.

In this article, computers, databases, expert system technology, and the *Logistic*, the *Compertz* curves are used to describe the competitive relationship between crop and weed, and a threshold forecast system for economic control of field weed is developed. The article expects to resolve the dynamic parameter determination and threshold statistic problems of the forecast model parameter simulation.