Study of Asian Soybean Rust

Nathalia H. Leite*, Fernando A. C. Gomide, Waldir C. de Jesus Júnior

Abstract

Brazil is the second largest producer of soybean. Soybean corresponds to 49% of the planted grain area in the country. In 2002 a disease named Asian Soybean Rust (ASR) was detected by the first time in Brazil. The financial losses, from 2002 to 2011, related to this disease were US\$ 1.9 billion. The development of a disease depends on three items: (1) virulent and/or aggressive pathogen, (2) susceptible host, and (3) favorable environment. Therefore, the objective of this research is to analyze how these three items affect the presence and intensity of the ASR. As initial part of the project, started in March of 2016, a literature review is presented and discussed.

Key words:

Artificial neural networks, asian soybean rust, non-linear modeling.

Introduction

Some studies have been conducted to understand the ASR. For example, Kim et al. (2005) present a fuzzy logic system designed to simulate the severity of ASR. In weekly simulation the model explained about 85% of the data.

Del Ponte et al. (2006) use empirical models to predict the severity of ASR. The models explain from 83% to 95% of the data. According to them, precipitation has more impact to the severity of the disease compared to temperature.

Twizeyimana et al. (2011) analyze the environmental factors that affect the development of ASR using linear regression analysis. This study suggests that planting date selection can be helpful in reducing soybean rust.

Lana et al. (2015) evaluate the relationship between crop and severity of ASR. They use meta-analysis from the application of fungicides.

Ferranti et al. (2005) compare results presented by conventional and Artificial Neural Networks (ANNs) methods to predict the relative humidity. The goal is to anticipate the possibility of ASR occurrence.

Lelis (2007) uses ANNs to analyze the relationship between ASR and temperature/relative humidity data.

Ferrari et al. (2008) present a smart system to estimate ASR by ANNs.

Moreira et al. (2011) apply ANNs for pattern recognition in the temporal dynamic of ASR.

Alves et al. (2011) develop and analyze two systems of adaptive neuro-fuzzy interference to describe ASR severity.

Results and Discussion

As can be seen, in general, ASR problem has been studied through fuzzy logic systems, empirical models, linear regression, meta-analysis, and ANNs.

ANNs present some advantages. They do not require detailed information about the physical processes of the system. Besides, they adjust to new information and perform a mapping of input-output. Also, they are fast and offer good answers even when the data are missing or confusing.

ANNs consist of processing units called neurons. Image 1 shows the processing unit scheme of an ANNs. Its operation occurs in four steps.

Image 1. Processing unit scheme.

Source: <http://sistemas-humano-computacionais.wikidot.com/capitulo:modelagem-e-simulacao-de-humanos> (adapted).

Conclusions

ANNs are a suitable tool for the study of ASR due to their flexibility in modeling and adjusting the structure / parameters of the model, from the data that describes the dynamics of rust. Therefore, ANNs will be used in this project to study the ASR. The hope is to increase the understanding of the disease, contributing to the adoption of efficient, safe and low environmental impact control strategies.

Acknowledgement

This research is being supported by São Paulo Research Foundation (FAPESP), since March of 2016, under grant #2015/19698-3.

Alves, M. C.; Pozza, E. A.; Costa, J. C. B.; Carvalho, L. G.; Alves, L. S. (2011). Adaptive neuro-fuzzy inference systems for epidemiological analysis of soybean rust. *Environmental Modelling & Software*, 26(9), 1089-1096.

Del Ponte, E. M.; Godoy, C. V.; Li, X.; Yang, X. B. (2006). Predicting severity of Asian soybean rust epidemics with empirical rainfall models. *Phytopathology*, 96(7), 797-803.

Ferranti, J. S.; Chaves, A. P.; Freitas, A. A. C. (2005). Estimation of the air humidity through the variable selection and ANNs in order to prevent the occurrence of ASR. *SBI-AGRO Londrina*, 09/2005.

Ferrari, J. W.; Mathias, I. M.; Tsukahara, R. Y. (2008). Development of a smart system for estimation of ASR through ANNs. *4º Enc. Eng. e Tec.*, Ponta Grossa, 08/2008.

Kim, K. S.; Wang, T. C.; Yang, X. B. (2005). Simulation of apparent infection rate to predict severity of soybean rust using a fuzzy logic system. *Phytopathology*, 95(10), 1122-1131.

Lana, F. D.; Ziegelmann, P. K.; Maia, A. H. N.; Godoy, C. V.; Del Ponte, E. M. (2015). Meta-analysis of the relationship between crop yield and soybean rust severity. *Ecology and Epidemiology*, 105(3), 307-315.

Lelis, V. P. (2007). Climate change and ASR in the Minas Gerais state. PhD thesis. Federal University of Viçosa, MG, 2007.

Moreira, E. N.; Vale, F. X.; Rodrigues, R. A. (2011). Pattern recognition favorability of temporal dynamics of Asian soybean rust using backpropagation neural network. *IPPC Joint Meeting*, Honolulu, 08/2011.

Twizeyimana, M.; Ojiambo, P. S.; Hartman, G. L.; Bandyopadhyay, R. (2011). Dynamics of soybean rust epidemics in sequential plantings of soybean cultivars in Nigeria. *Plant Disease*, 95(1), 43-50.