Chapter 61
Using MLP Neural Networks to Detect Late Blight in Brazilian Tomato Crops

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ABSTRACT

The food quality is a major issue in agriculture, economics, and public health. The tomato is one the most consumed vegetables in the world, having a significant production chain in Brazil. Its culture permeates many economic and social sectors. This paper presents a technological approach focused on enhancing the quality of tomatoes crops. The authors developed intelligent computational strategies to support early detection of diseases in Brazilian tomato crops. Their approach consorts real field experiments with inexpensive computer-aided experiments based on pattern recognition using neural networks techniques. The recognition tasks aimed at the identification foliage diseases named late blight, which is characterized by the incidence of brown spots on tomato leaves. The identification method achieved a hit rate of 94.12%, by using digital images in the visible spectrum of the leaves.

INTRODUCTION

Diseases in plants cause significant economic and production losses in the agricultural industry worldwide. Monitoring of health and detection of diseases of crops is critical for sustainable agriculture. The tomato (*Solanum lycopersicon*) is a crop culture that requires extreme care regarding fertilization and phytosanitary treatment. Tomato cultivars are highly susceptible to contamination in the field, but its resistance to diseases and pests may vary widely. Due to the large quantity of diseases that affect tomato plants, the crop ranked in the second position in pesticide consumption per planted area in Brazil (Neves et al., 2003, Sankaran et al., 2010, Barbedo, 2013).

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Tomatoes are widespread throughout the world and characterizes the most economically important vegetable crop worldwide. It has an essential role in the Brazilian agricultural production, representing one of the most important cultures in the state of Rio de Janeiro, which is one of the largest Brazilian producer states. In 2010, about 204,905 tons of tomatoes were produced, raising approximately R$ 166,547 million in sales (IBGE, 2010). However, the indiscriminate use of pesticides in tomato brings serious problems not only to human health but also to the environment, presenting high rates of residual pesticides in tomato fruits. The sum of these factors, combined with high production costs, make tomato farming a culture of high risk (Macedo et al., 2005). Thus, the development of novel technological solutions that reduce operating costs, pesticide use, and environmental impact to yield products with better quality is essential.

Tomato farmers have a broad range of genotypes to select suitable crops. However, the cultivation of such crops for optimum yield and quality food is highly technical and can be enhanced with the aid of a computational support. The goal of this paper is to present novel computer-based techniques that increase the productivity of tomato crops on small properties in the state of Rio de Janeiro. In this study, we expand our previous works (Vianna & Cruz, 2013a, 2013b; Nunes et al., 2014, Cruz et al., 2015). The approach aims at supporting small farmers to detect late blight, a foliage disease in tomato crops, by using pattern recognition, more specifically based on Multilayer Perceptron (MLP) neural networks. The implementation of such expertise on small properties of tomatoes crops are a very challenging endeavor (Vianna & Cruz, 2013a); especially if considering the difficulties involved in the data manipulation by underqualified workers and its further treatment to enhance the detection of late blight.

This paper is organized as follows. Section 2 characterizes the vegetable and its major disease, and computational techniques that can be used by farmers to detect tomato late blight. Section 3 presents the related work and compares them with the proposed approach. Section 4 presents the computer-based experiments and results involving pattern recognition of the late blight disease in tomato plants with neural network techniques. Section 5 presents the conclusions achieved and future works to be developed.

LATE BLIGHT IN TOMATO CROPS

The tomatoes are grown and eaten all around the world. It was originated from the South America (Andean region) and was imported by Europe in the 15th century. Domestication on a much more intense level occurred throughout Europe in the 18th and 19th centuries (Sims, 1980). Since the beginning of the 20th century, farmers created an enormous range of morphologically different cultivars and forms from a single species *S. lycopersicum*. Through domestication, the modern tomato genotypes (mostly hybrids varieties) have been developed with different shapes, colors, and sizes. Nowadays, the tomato is consumed in several ways, including raw tomatoes in salads, and processed into ketchup, pulp, juice, puree, and sauce or soup.

The tomato is a climacteric fruit presenting high perishability, and the final yield of its culture is conditioned by the development of several diseases and pests (DISQUAL, 2010). The current model of tomato crop plant in Brazil requires substantial investments by farmers, as sprays of pesticides every three days and intensive use of manpower to keep the crop healthy. These factors increase the cost of production and generate losses on local fauna, bringing imbalance to the local ecosystem or causing diseases on farmers and workers. This imbalance can be evidenced by the resurgence of several pests and the emergence of new ones, with increased resistance to pests to some products used in the crops