



A GEOGRAPHIC INFORMATION SYSTEM FOR MAPPING APPLE QUALITY

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Abstract. Technologies related to precision agriculture (AP) have contributed to the development of decision support systems. In this work a tool is presented that allows mapping apple quality indexes georeferenced to transform them into a graphic variable that serves as support for orchard management. The system was developed in Java language, with PostgreSQL database and geographical extension PostGIS. The system has been named "Apple Show" and can analyzed the production areas, mark the points, classify and interpolate them, presenting the results in the form of maps.

Keywords. *Precision Agriculture, decision support system, Geographic Information System*

Introduction

The technological advance has been fundamental in the agricultural context and is not only related in the machines or equipment innovation, but also in the evolution of the production processes, being the productivity, generally used in the measurement of the progress and production efficiency (GONZALEZ, COSTA, 1998).

Besides to the productivity factor, fruit quality is of fundamental importance in the context of apple production (Giraridi, 2004). In Brazil, the classification of apples follows Normative Instruction No. 5 of the Ministry of Agriculture, Livestock and Supply (MAPA, 2006), which

presents a technical regulation for identification and qualification of apples. This regulation defines the apple in four categories: Extra, Category 1, Category 2 and Category 3, in descending order of quality. Fruits that do not fall into these categories are considered Category 4 or Industrial. This technical regulation provides parameters for the definition of quality categories by setting tolerance values for color and defects allowed by category. This technical regulation provides parameters for defining the quality categories by setting tolerance values for the color and for defects allowed by category.

To remain competitive, producers constantly seek to meet consumers demand by producing good quality food. According to Guedes, Sena and Toledo (2012), quality programs in the production chain have been adopted in several production lines, including fruit, with strong international acceptance.

Fruit-growing has become one of the most important segments of Brazilian agribusiness, considering that aspects related to high profitability and expressive use of labor contributes significantly to the economic and social development of the country and is an alternative to the advance of Brazilian exports. Favored by diverse edaphoclimatic conditions, which allow the cultivation of different variety and their wide territory (VITTI, 2009), Brazil can grow even more in the productive scenario of fruit growing, despite already presenting itself as the third largest producer of fruits worldwide (Rodrigues, 2015, Andrade, 2012).

The apple production was chosen to evaluate the concept, considering that this crop demands a great amount of information for the appropriate management. The generated maps allow to present information to the producer to simplify the interpretation, generating subsidies for the decision making, both for the management of the orchards and for the use of the harvested fruit. Due to the feasibility of use, access to the application is performed in a web environment, making use of an application server made available in the cloud context.

Methodology

The programming language used for the development of the system was Java (CLARO; SOBRAL, 2008). The JavaServer Faces (JSF) technology was used for the development of the graphic interfaces of the system, and for Geary and Horstmann (2010) it provides the necessary code for event programming and is based on the Model-View-Controller (MVC), simplifying the development of systems.

The database used was PostgreSQL, which is an open-source software, available free of charge (RIBAMAR, 2006) and allows the integration with the PostGIS extension for the storage and manipulation of spatial data (Vermeij, 2002).

The experimental area, located in the municipality of Vacaria/RS, Brazil with the central geographical coordinates 28°30'01"S and 50°49'30"W, is cultivating apples trees for more than 10 years. In this field of 3.13 ha, 1,600 apple trees are cultivated, Figure 1.



Fig. 1 – Experimental field of 3.13 ha (highlighted) located in Vacaria/RS, 28°30'01"S and 50°49'30"W and the sampling points highlighted with red balloons.

Considering the classification recommendations of MAPA 2006, the software was developed aiming to allow mapping of the quality of the fruits for orientation of harvest, adding value through uniformity and quality of the harvested apple.

For mapping, the user must import a file with the geographic coordinates (long, lat) of the area in which the thematic map is to be created, using inverse of distance or moving average interpolators, Figure 1. At each sampling point the fruit is classified according to firmness of the pulp, soluble solids content (°Brix), color index of the fruit epidermis and caliber.

Based in contour maps generated, the system creates the quality maps using the same pixel size. The process consists in calculating the difference between the highest and the lowest value for each score at the sampling points, creating four intervals. Then, it is assigned to each point in the series a value to generate a map for each score. At the end of the process another map is created, now with the sum of the score of each point, creating the quality map, where the highest values correspond to the fruits with higher quality.

Results and discussion

A computational tool that allows to gather, interpret and present information related to apple production, was developed. The system also offers the opportunity of various comparisons to find correlations or conditions that depend on two or more variables.

In the visualization screen, the list of registered areas, with a name identifier, entered by the user at the time of registration, and which owner it belongs to, is displayed. The user can click the "view on the map" option and the system displays in an image provided by the Google Images environment the highlighted area and its outlines, as shown in Figure 1.

The map generation feature allows to transform a sample of georeferenced values into a visual variable, displayed in a thematic map and able to translate the sample values under a user-defined color system, serving as a tool for abstraction and understanding of values.

An example is the scoring map for samples of pulp firmness and soluble solids, which are the regions closer to be ripe and consequently can be harvested, Figure 2. The classification of the caliber and fruit color of the epidermis is intended to show the zones that present the fruits with better classification, Figure 3.

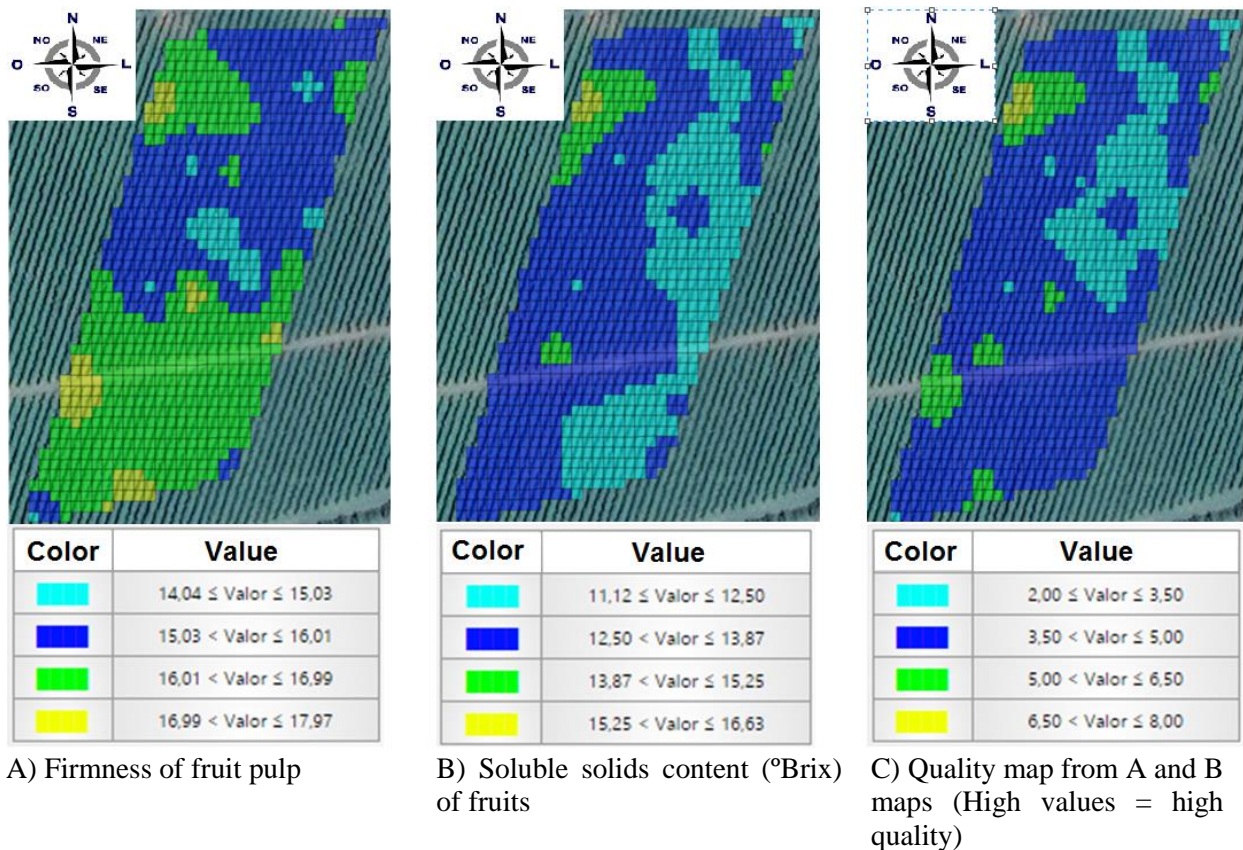


Fig. 2 – Thematic maps of fruit pulp firmness (A), fruits soluble solids content (°Brix) (B) and the quality map based on (A) and (B).

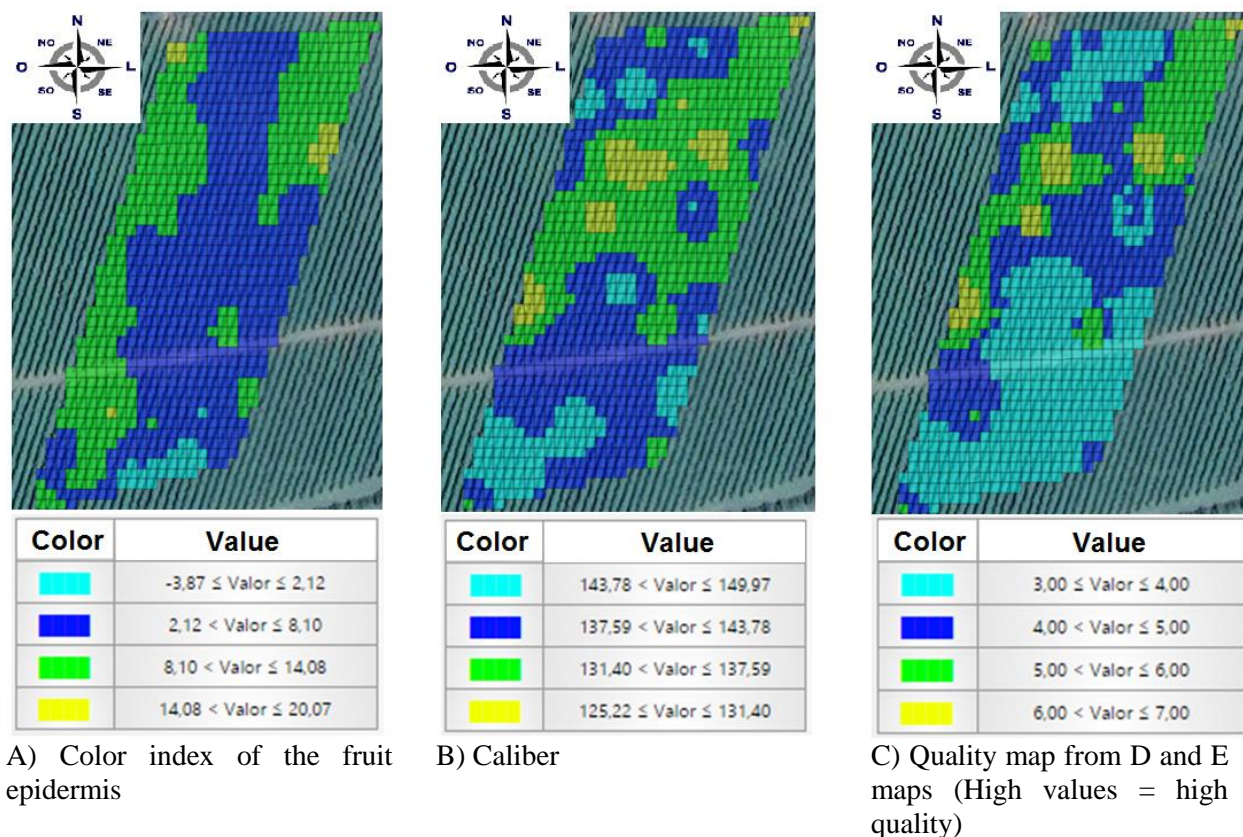


Fig. 3 – Thematic maps of fruit color index (A), fruits caliber (B) and the quality map based on (A) and (B).

CONCLUSION

The proposed software managed to present apples quality thematic maps based on parameters used to classify the fruit for the internal and export market.

The developed system presents large amounts of georeferenced information in the form of maps that facilitate the reading and interpretation by the growers, when compared to the presentation of the same information in reports and sheets, as is common in many Brazilian properties.

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