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Suitable climate for rubber trees affected by the South American Leaf Blight (SALB): Example for identification of escape zones in the Colombian middle Magdalena

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ABSTRACT

South American Leaf Blight (SALB), caused by the fungus *Pseudocercospora ulei*, is the major constraint for rubber tree cultivation in Latin America, continent of origin of the rubber tree. The use of resistant tree cultivars and the identification of escape zones seem to be the best disease control measures. In order to characterize the climate and the pedological parameters in the region of Middle Magdalena, Colombia, we used temperature, relative humidity and annual rainfall records for a 20-year period (1990–2010) from 19 weather stations distributed across the region, together with definitions of the soil units for the area. With the recorded data, we calculated annual and monthly averages of temperature and relative humidity, annual rainfall, annual water balance, annual potential evapotranspiration, number of months with rainfall lower than 50 mm and 100 mm, and number of months with relative humidity lower than 75%. To determine the suitable climate for the rubber crop facing SALB, these results were interpolated through Inverse Distance Weighting with the software ArcGis 9.3 for each variable and their combinations, having as references the plant requirements and the disease escape areas. Regarding the annual rubber tree evapotranspiration requirement, the map showed that the region of Middle Magdalena is suitable for the rubber cultivation. However, La Gloria (Cesar), Regidor (Bolívar) and Gamarra (Cesar) are not suitable for rubber cultivation owing to the high soil hydric deficit (>500 mm). When we considered the rubber tree's requirements, the region was divided into the following types of areas: two unsuitable, two marginal and one suitable. However, considering the disease escape requirements, this region was divided into one unrestricted area and six preferential areas with different restrictions to the SALB control. The most important area of the Middle Magdalena Region is not an escape zone, hence in these areas, the use of highly productive clones resistant to *P. ulei* is suggested.

1. Introduction

The South American Leaf Blight (SALB), caused by the fungus *Pseudocercospora ulei*, -formerly *Microcyclus ulei*- (da Hora et al., 2014), is the most destructive disease of the rubber tree (*Hevea brasiliensis* Muell. Arg.) in Latin America (Rivano et al., 2010). On susceptible cultivars, infected leaves fall and are replaced within a few weeks by new ones that can also succumb to SALB attacks. The most susceptible trees may consequently die from exhaustion as a result of repeated defoliation. Chemical control of SALB is technically feasible, but it is neither economically profitable nor ecologically desirable. The use of resistant and high-yielding rubber tree cultivars seems to be the best way to increase natural rubber production in South and Central America, as well as to anticipate an accidental introduction of SALB in Africa or Southeast Asia (Le Guen et al., 2011). The SALB fungus has a strong evolutionary potential (Barrès et al., 2012) and justifies the effort toward the development of a durable strategy to control this disease.

The identification of zones favorable for *Hevea* cultivation but unfavorable for the fungus' development (hereafter referred to as

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escape zones) could be a useful alternative to manage the disease. To identify escape zones, the annual water balance, relative humidity and dry season rainfall must be considered (Ortolani, 1986). The dry season is considered the most important season because it corresponds to the period of defoliation and refoliation of the rubber trees, and during this time, the plants are susceptible to the pathogen due to the presence of young leaves (Gasparotto et al., 2012). The elaboration of suitable climatic maps, known as zoning, would therefore be considered an important tool to give practical, logical and coherent recommendations for the disease management. These maps could serve as the basis to define the policies of the agriculture sector (da Silva et al., 2013). To achieve this, in the SALB escape zone studies the annual average temperature, true evapotranspiration, water deficit, as well as the altitude and pedological suitability of the area are considered.

The annual average temperature of 20 °C has been adopted as the tolerable lower limit for the rubber tree (Zong and Xuequim, 1983). For the bordering (frost-free) tropical regions, this corresponds to climatic conditions with seasonal temperature intervals for good growth and latex production (da Silva, 2007). Due to its origin in tropical and equatorial regions where it receives cold air streams coming from polar regions, the rubber tree can withstand low temperatures; hence the reason it has managed to successfully develop in subtropical regions (de Camargo and de Camargo, 2008). Concerning its true annual evapotranspiration, this is equal to 900 mm, which corresponds to an annual average temperature of 20 °C (Zong and Xuequim, 1983). Zong and Xuequim (1983) observed that respiration rate exceeds the photosynthetic rate in conditions with temperatures higher than 40 °C. For this reason, the thermic limits favoring photosynthesis lie between 27 and 30 °C, but the range of 18–28 °C is more frequently cited because it favors latex flow (Ortolani, 1986).

As for *P. ulei*, more spores are produced between 23 and 25 °C, although sporulation can occur below 20 °C with variable intensity depending on the clone-isolate combination. As a result, the annual average temperature is often one of the criteria considered as a limiting factor in the development of this pathogen (da Silva, 2007). The annual water deficit is also considered as an important factor in the SALB escape zones. The limit is considered to be 300 mm and considering the root depth that allows tolerance of dry periods, it could be greater than that (Ortolani, 1986). The greater the amount and the longer the duration of the water film on the rubber foliage, the higher the spores' probability of penetrating the leaf tissue (de Camargo and de Camargo, 2008). Concerning the humidity levels, SALB development requires 6 h of dew formation (da Silva, 2007). When the relative humidity is higher than 95%, the disease incidence increases considerably. High disease incidence can also happen when there is abundant dew formation in areas with depressions or poorly drained slopes (de Camargo and de Camargo, 2008).

The Colombian Middle Magdalena region corresponds to the Inter Andean valley of the Magdalena river between the Honda currents and the Caribbean coastal plains (Fig. 1). The importance of the Middle Magdalena region is its strategic location for latex

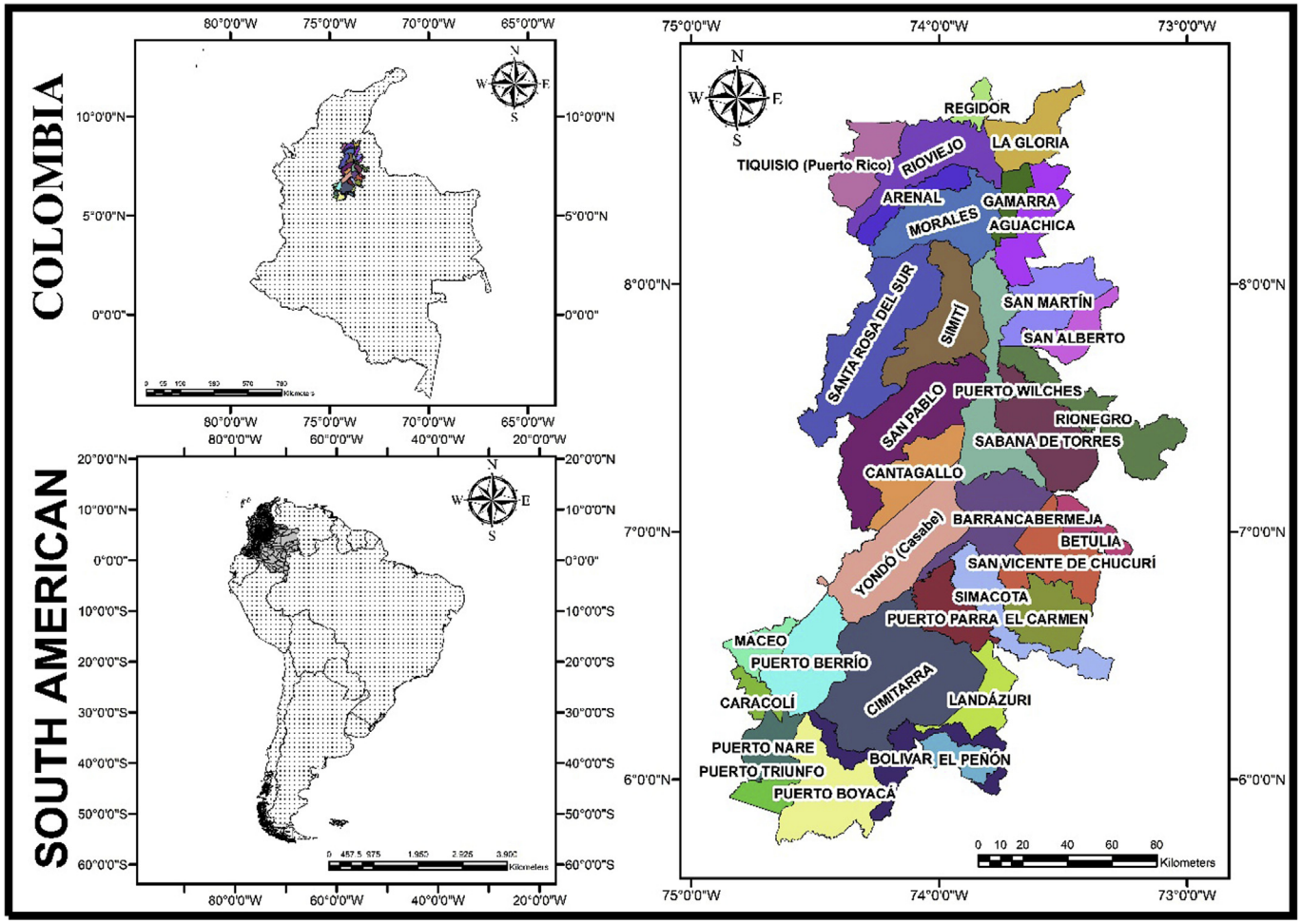

Fig. 1. Study area – Colombian Middle Magdalena.