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Genetic instability in plants associated with vehicular traffic and climatic variables

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ABSTRACT

To characterize the effect of vehicular traffic on air quality, the micronuclei of *Tradescantia pallida* tetrads were counted. Young inflorescences of *T. pallida* (Rose) D.R. Hunt var. *purpurea* were collected in 2010, 2011, and 2012, from three sites subjected to different intensities of vehicular traffic. The sites were located in the municipality of Dourados, in the State of Mato Grosso do Sul, Brazil. A standardized methodology was used to analyze the *Tradescantia* micronuclei, in order to evaluate the mutagenic potential of the local air pollutants. Statistical analyses using the Pearson's linear correlation were employed to determine the relationship between relative humidity and temperature, and the average number of micronuclei. In this study, an increase in the average number of passing vehicles was correlated with an increase in the frequency of micronucleus formation. Climatic factors also influenced micronucleus formation, although vehicular traffic remained the most important factor. Thus, the *Tradescantia* micronuclei assay may be a useful method of assessing air quality.

1. Introduction

Atmospheric contamination and pollution due to human activity are primarily caused by vehicular traffic and industrial activity (Rodriguez et al., 2011). Because of an increase in anthropic activity, the emission of air pollutants has increased substantially in recent decades, directly influencing air quality and affecting human health, ecosystems, the climate, plants, and animals (Kanakidou et al., 2011).

The use of plants in cytogenetic biomonitoring has several advantages over conventional methods, including larger sampling sizes, lower operational costs, higher levels of sensitivity, and the ability to evaluate rates of chromosomal damage using rapid cytological preparations. The technique allows for the detection of correlations between levels of atmospheric pollution and genetic mutations (Crispim et al., 2014). Climatic variables such as temperature and relative humidity can also influence the quantity of air pollutants dispersed; these pollutants may contribute to genetic instability (Pereira et al., 2013a). The Tradescantia Micronuclei (Trad-MCN) assay detects the presence of micronuclei (MCN) in meiotic tetrads. According to Carvalho (2005) and Meireles et al. (2009), aneugenic and clastogenic agents can cause the breakage and loss of chromosomes not attached to the spindle during meiotic cellular division in the pollen grains cells; the resulting DNA fragments can form small round structures called micronuclei. This study used MCNs as identifiers of genotoxic damage in *Tradescantia pallida* (Rose) D.R. Hunt var. *purpurea*.

The Trad-MCN assay has been used in several scientific studies and has several advantages, including its straightforward methodology, easily accessible sample material, and sensitivity to genotoxic agents. Therefore, the Trad-MCN test enables chromosomal damage to be evaluated using rapid cytological preparations, and it is an important tool for the detection of clastogenic effects caused by atmospheric pollutants (Pereira et al., 2013b).

Atmospheric pollution has recently increased in the city of Dourados (MS-Brazil). It is important to understand the environmental effects of this increase, and conduct environmental biomonitoring in order to analyze its effects on living organisms. This study assessed the number of MCNs in *T. pallida* tetrads and evaluated the relationship between MCN formation and vehicular traffic levels over three consecutive years.

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2. Materials and methods

2.1. Study area and collection period

Three ornamental *T. pallida* flowerbeds, located in different parts of the city of Dourados-MS, Brazil were used as study sites. Each flowerbed was subjected to a different intensity of automotive vehicle traffic. At these sites, the number of passing vehicles in 2010, 2011, and 2012 was counted. The sites were located at 22° 14.867′S, 054° 48.286′W (site 1); 22° 13.136′S, 054° 48.588′ W (site 2); and S 22° 11.796′W 054° 56.025′ (site 3) (Fig. 1).

Data on the meteorological conditions (air temperature and relative humidity) to which the plants were exposed during each biomonitoring period were collected using a digital hygrothermometer (Mimipa). The meteorological, automotive vehicle traffic, and Trad-MCN data were collected between May and August of each study year. The Trad-MCN analyses were conducted using a standardized methodology, in which young *T. pallida* inflorescences were collected and fixed in Carnoy solution for 24 h, and then transferred to 70% ethanol.

2.2. The Trad-MCN test

The methodology proposed by Ma (1981) was adapted and used for the preparation of biological material. At least five slides were prepared from specimens collected at each sampling site (1, 2, and 3), leading to the production of 60 slides per year (2010, 2011, and 2012). The MCNs of 300 tetrads on each slide were counted under a microscope (Bioval) at 400 × magnification, from which the average number of micronuclei at each sampling site was calculated.

2.3. Statistical analyses

The experiment was conducted using a randomized design with a factorial scheme: 3 (years) × 4 (collections) × 3 (sites), with five replicates. The averages were compared using Tukey's test at a significance level of 5%. Pearson's linear correlation analysis was used to evaluate the climatic variables and the frequency of MCN formation.

3. Results and discussion

The average number of MCNs detected over the course of the study in *T. pallida* tetrads from the three different study sites, and three different harvesting times revealed that, over time, the MCN frequency increased at a rate directly proportional to the intensity of vehicular traffic, the temperature, and the relative humidity at each sampling site. Over the course of the study period, the number of automotive vehicles passing each site varied annually.

The air quality results obtained for the years 2010, 2011, and 2012 show that the Trad-MCN assay can effectively estimate the genetic instability related to different levels of vehicular traffic

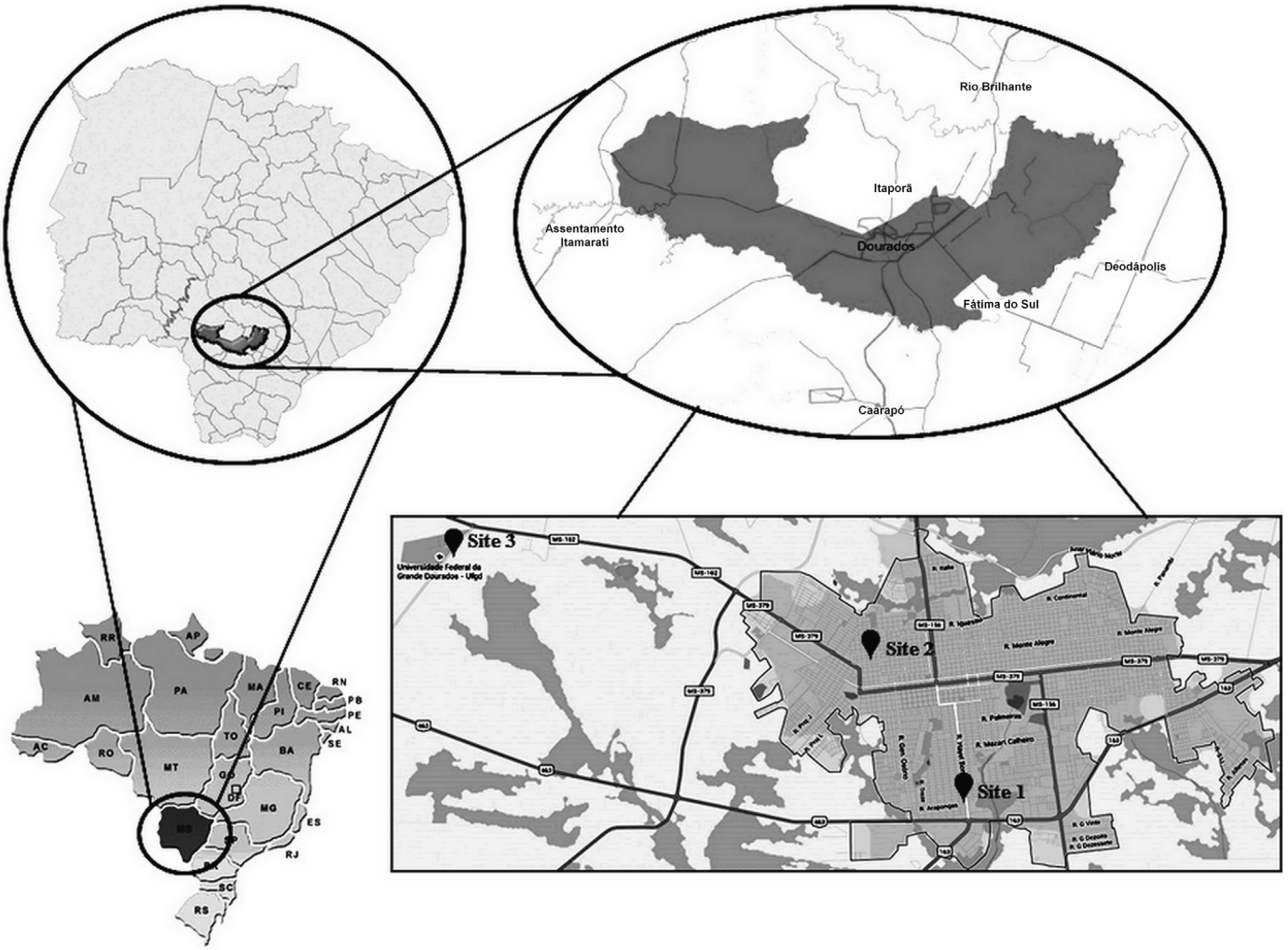

Fig. 1. Map of Dourados, MS, Brazil, showing the three monitored locations (site 1, site 2, and site 3).