MEASUREMENTS OF THE DIAMETER OF THE FIG STEM (*FICUS CARICA*) IN ROMANIA FOR SIX YEARS SHOW THE TRANSITION FROM A SMALL SHRUB TO A TREE-LIKE PLANT

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Abstract. *The fig tree, Ficus carica L., 1753, is a woody species native to southwest Asia, common in the Mediterranean area. Although it sporadically appeared as a spontaneous plant in southern and southeastern Romania, it hardly survives the cold season. Therefore, in central and northern Romania it appeared mostly as a small shrub. This paper aims to signal the expansion of the species to the north, as a result of climate change in the region (Transylvania). Our studies are based on measuring and tracking the dynamics of stem diameter each winter for six years (2016 - 2021). The experimentally planted fig plants in Cluj - Napoca show an increase in the diameter of the stem in the last four years to a size that will allow them to withstand the frost of winter. Thus, from a creeping shrub (Ficus carica L., 1753), the plant begins to take on the appearance of a tree with erect stems. Measurement data are presented in the paper. Even if global warming is considered by some authors to be a fact, and by others a spontaneous geological trend and only with regional effects, we can say that, at the country level, climate warming is certain in Romania.*

Keywords*: creeping shrub, erect stems, climate change, mild winters, Ficus carica.*

INTRODUCTION

The fig tree, *Ficus carica*, is a woody species native to southwest Asia (Crisosto et al 2011), common in the Mediterranean area (Barolo et al 2014; Falistocco 2020). Although it sporadically appeared as a spontaneous plant in southern and southeastern Romania, it hardly survives the cold season (Ahmad et al 2018). Therefore, in central and northern Romania, the fig plant appeared mostly as a creeping shrub, difficult to be cultivated for production purposes (Ahmad et al 2018; Asănică et al 2019).

This paper aims to signal the expansion of the species to the north, as a result of local climate change in Romania (see also Odagiu et al 2021). In addition to those reported by Odagiu et al (2021), we will present in this paper the data of the measurements, which argue the interpretations made.

MATERIAL AND METHODS

The place of the experiment was a garden in Cluj County, Cluj-Napoca, 46.77 N, 23.60 E. This place is located very close to the Botanical Garden "Alexandru Borza" (100 m). The studies lasted for a period of six years (2016-2021). The plants were planted directly in the soil, in 2014, in the form of 10 cuttings with a formed root. The planting site was chosen next to a fence, according to the recommendations circulated among gardeners, to ensure adequate thermal protection over the winter. The plants were given two years to develop their root system before the measurement began. Checks have shown that there is no increase in stem diameter between the measurements in November, December and March. Therefore, the measurements were carried out at the end of each season, exclusively at the base of the stems that were not affected by frost until the end of December (or January at the latest). The measurements were performed in the same way each year, using a caliper. Some of the cuttings perished, but additional young shoots also appeared, which, starting with 2016, were removed.

A number of 6-8 stems were measured in diameter each year, as close to the ground as possible. With the raw data, the arithmetic mean, dispersion and standard deviation were calculated. The values obtained for the standard deviation allowed the use of the arithmetic mean to draw a graph of the evolution of the diameter of the stem of the fig plant.

RESULTS AND DISCUSSIONS

The experimentally planted fig plants in Cluj-Napoca show an increase in the diameter of the stem in the last four years to a size that will allow them to withstand the frost of winter. Thus, the increase in the diameter of the stem of fig plants is very evident starting with 2018 (1.025 cm), gradually increasing to 4.0167 cm in the winter of 2021 (see table 1, figure 1). Thus, from a creeping shrub, the plant begins to take on the appearance of a tree with erect stems.

The maximum diameter reached at the base of the fig stem is 5 cm, in 2021, and it continues to grow as it has passed well over the winter frost (figure 2). At this size, the stem will be more and more resistant to winter cold.

The results obtained do not surprise us. If we look at how the average annual temperature has evolved in recent decades (see figure 3), the expansion of the fig tree to the north is an expected fact. Since 1979, the average annual temperature has increased from 7.2 °C to 9.3 °C, reported for 2021.

Table 1

Evolution of the diameter of the fig plant stem during 2016 – 2021

Year	2016	2017	2018	2019	2020	2021
Arithmetic mean	0.9250 cm	0.9875 cm	1.025 cm	1.6571 cm	2.4000 cm	4.0167 cm
Standard Deviation	0.088130	0.166361	0.166868	0.335940	0.115468	0.285662

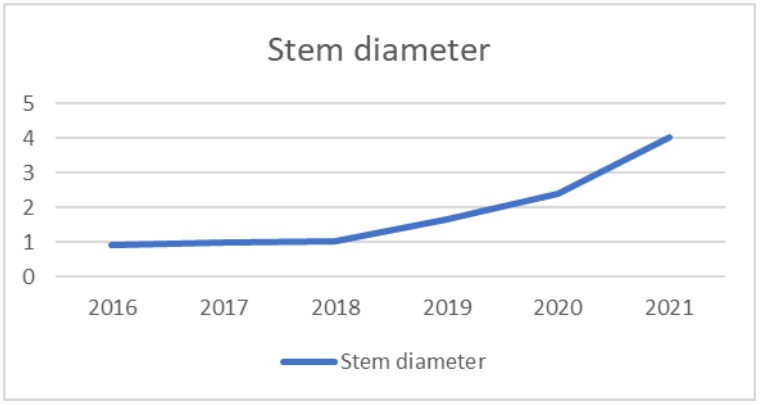

Fig. 1. Evolution of the diameter of the fig plant stem during 2016 – 2021.

Fig. 2. Fig stem with a diameter of 5 cm (original picture).

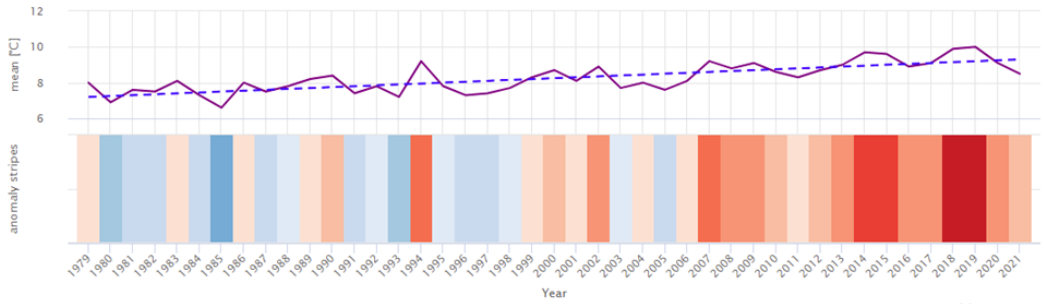

Fig. 3. Mean yearly temperature, trend and anomaly, 1979-2022, in Cluj-Napoca 46.77 N, 23.60 E. Source: https://www.meteoblue.com/ro/climate-change/cluj-napoca_rom%c3%a2nia_681290

The graph in Figure 3 shows an estimate of the average annual temperature for the Cluj-Napoca region. The dotted blue line represents the linear trend of climate change. If the trend line is ascending from left to right, the temperature trend is positive and is warming in Cluj-Napoca due to climate change. If it is horizontal, no clear trend is observed, and if it is downward, the conditions in Cluj-Napoca cool down over time. At the bottom, the graph shows the so-called heating stripes. Each colored band represents the average temperature for one year: blue for colder years and red for warmer years.

Similar studies from other regions by other authors also appear to indicate a northward expansion of *Ficus carica*. For instance, Wirth et al (2020) reported on the spreading to north of the fig tree. Moreover, they discuss about naturalization of *Ficus carica* in Hungary, as an opportunity to cultivate an exotic but commercial species in terms of horticulture (see details in Wirth 2020). Up to present, such approaches were unusual for a country with temperate climate like Hungary.

In Romania, Odagiu et al (2021) signal a possible northward expansion of the species but only on the basis of empirical observations. This group of researchers also explains the phenomenon as a result of local climate warming, more precisely, due to mild winters.

Although the fig tree is an invasive species (Holmes et al 2014), we do not consider that there is such a danger in Romania in the near future, in the current climatic conditions. If

there is a bad part of the findings from our study, it is the obvious local warming and mild winters, which are likely to gradually change the architecture of the original ecosystems. Among the opportunities that could be exploited in practice, we should mention that the fig tree is a species of economic, commercial and biomedical interest (Purnamasari et al 2019; Teruel-Andreu et al 2021; Shahrajabian et al 2021; Khadivi & Mirheidari 2022; Ou et al 2022) and can now be cultivated in new geographical areas. The situation seems to be similar to the northward expansion of the vine cultivation limit (Petrescu-Mag et al 2016; Teil 2022).

CONCLUSIONS

The experimentally planted fig plants in Cluj-Napoca show an increase in the diameter of the stem in the last four years to a size that will allow them to withstand the frost of winter. Thus, the increase in the diameter of the stem of fig plants is very evident starting with 2018 (1.025 cm), gradually increasing to 4.0167 cm in the winter of 2021. Thus, from a creeping shrub, the plant begins to take on the appearance of a tree with erect stems.

Although the fig tree is an invasive species, we do not consider that there is such a danger in Romania in the near future, in the current climatic conditions. If there is a bad part of the findings from our study, it is the obvious local warming and mild winters, which are likely to gradually change the architecture of the original ecosystems. Among the opportunities that could be exploited in practice, we should mention that the fig tree is a species of economic interest and can now be cultivated in new geographical areas.

Even if global warming is considered by some authors to be a fact, and by others a spontaneous geological trend and only with regional effects, we can say that, at the country level, climate warming is certain in Romania, a fact also demonstrated by the average annual temperatures.

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