

1. Introduction

Improving air quality is a major challenge worldwide. Finding natural solutions, such as those in forests and tree plantations, is now a widespread practice for improving air quality and retaining PM10 particles. In this study, we assessed the contribution of *Robinia pseudoacacia* L. (black locust) plantations, established at former open-cast mines of the Lignite Centre of Western Macedonia (Greece), in retaining PM10 particles.

Robinia pseudoacacia L., is a species that has been widely used by the Public Power Corporation (PPC SA) at the Lignite Center of Western Macedonia (Greece) for the restoration of mines and the establishment of vegetation on heavily degraded soils. It is worth mentioning that in the last 20 years about 2,570 ha of plantations have been created with this species.

2. Materials and methods

2.1 Sample collection and quantitative PM analysis

Leaf sampling was performed along 4 transects, each consisting of 5 trees, twice a month during the period May to October 2021 (Map 1).

The first tree of each transect was selected to be on the front row facing the PM10 emitting source, while the next ones were selected with a distance of 10 m among them.

Sampling was also done from 3 positions inside the tree canopy (high - medium - low). Thus, a total of 660 leaf samples were collected.

The samples were kept at -20 ° C until the analysis, which was performed at the Physicochemical Laboratory of the Lignite Center of Western Macedonia (Greece), according to the methodology of Popek et al. 2011.

2.2 Ambient air quality monitoring system

Air quality monitoring is carried out through the existing network of environmental monitoring of PPC SA. The network is common for Steam Power Plants and Mines and includes in total 9 stations for automatic measurement of pollution and meteorological parameters. In this study, PM10 and meteorological data were collected and processed for the period May – October 2021.

2.3 Leaf Area and Leaf Area Index (LAI)

Leaf Area was determined with ImageJ. Prior to this, the samples were scanned, placed on scaled paper and photographed from a fixed distance.

a. Leaf Area Index was assessed with the portable analyzer LAI-2000 (LICOR Biosciences GmbH).

3. Results

- For the period May – October 2021, the average atmospheric PM10 concentrations were below the threshold of 40 $\mu\text{g}/\text{m}^3$ (Figure 1).
- There was a significant effect of the seasonality on PM10 retention; from May till August there was a gradual increase in the amount of dust captured by the leaves (Figure 2). The highest values were found in August and October, although the production of PM by the mines was not the highest in these months (Figure 3).
- There was no correlation between the results of LAI and the seasonal variation of PM10 (Figure 4).
- PM10 retention gradually decreased with increasing distance from the source (Figure 5).
- Maximum dust retention was observed at the lower vs the higher part of the tree canopy (Figure 6).
- The amount of PM10 retained by black locust canopies was extrapolated over the entire study area, based on LAI estimations, during the 2021 growing season (Figure 7). The average amount of dust retained by black locust leaves was 1,229.56 $\mu\text{g}/\text{m}^2$ (0.0123 t/ha).



Map 1: Sampling along 4 transects at the South Pedio Mine

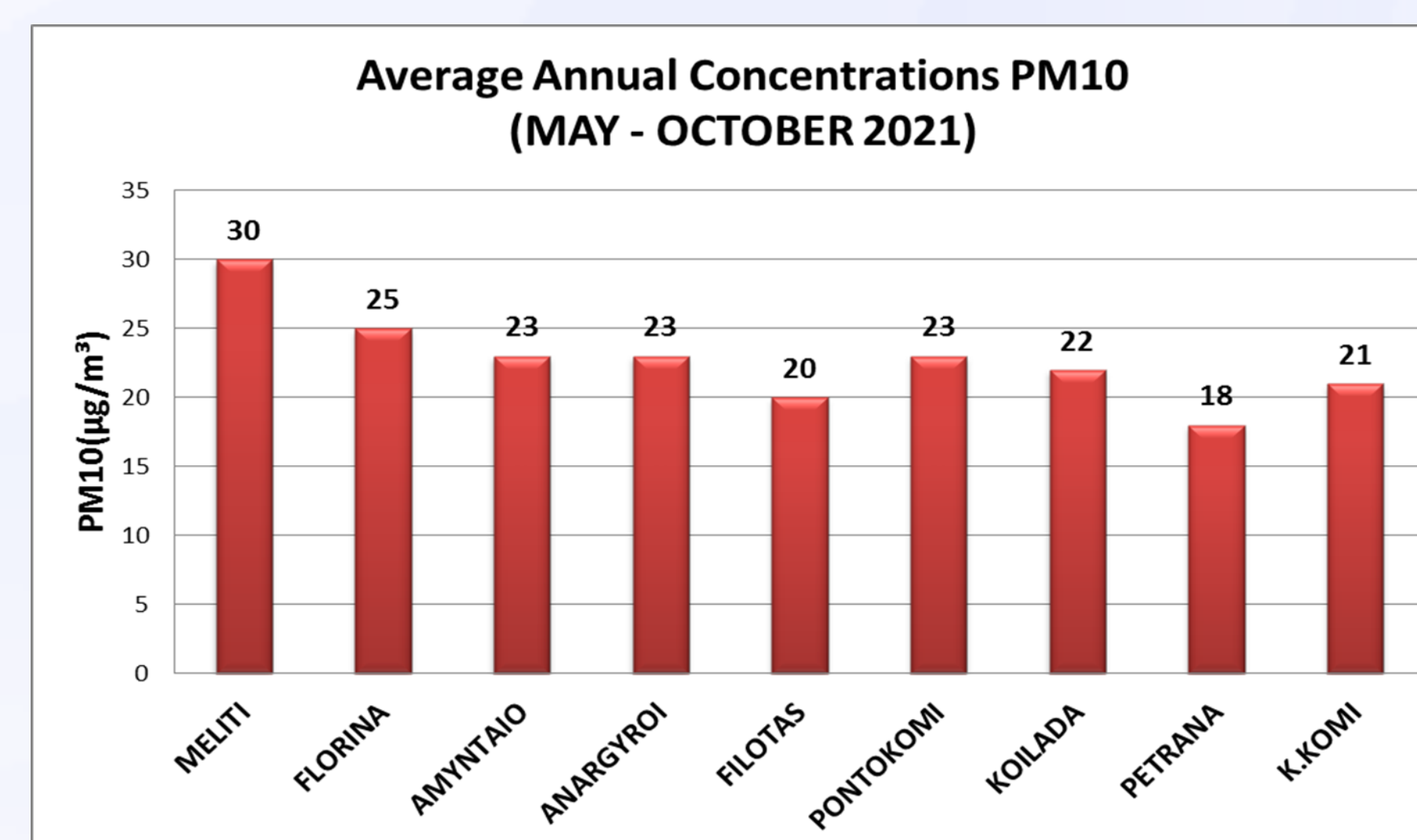


Figure 1: Points of stations measuring atmospheric quality

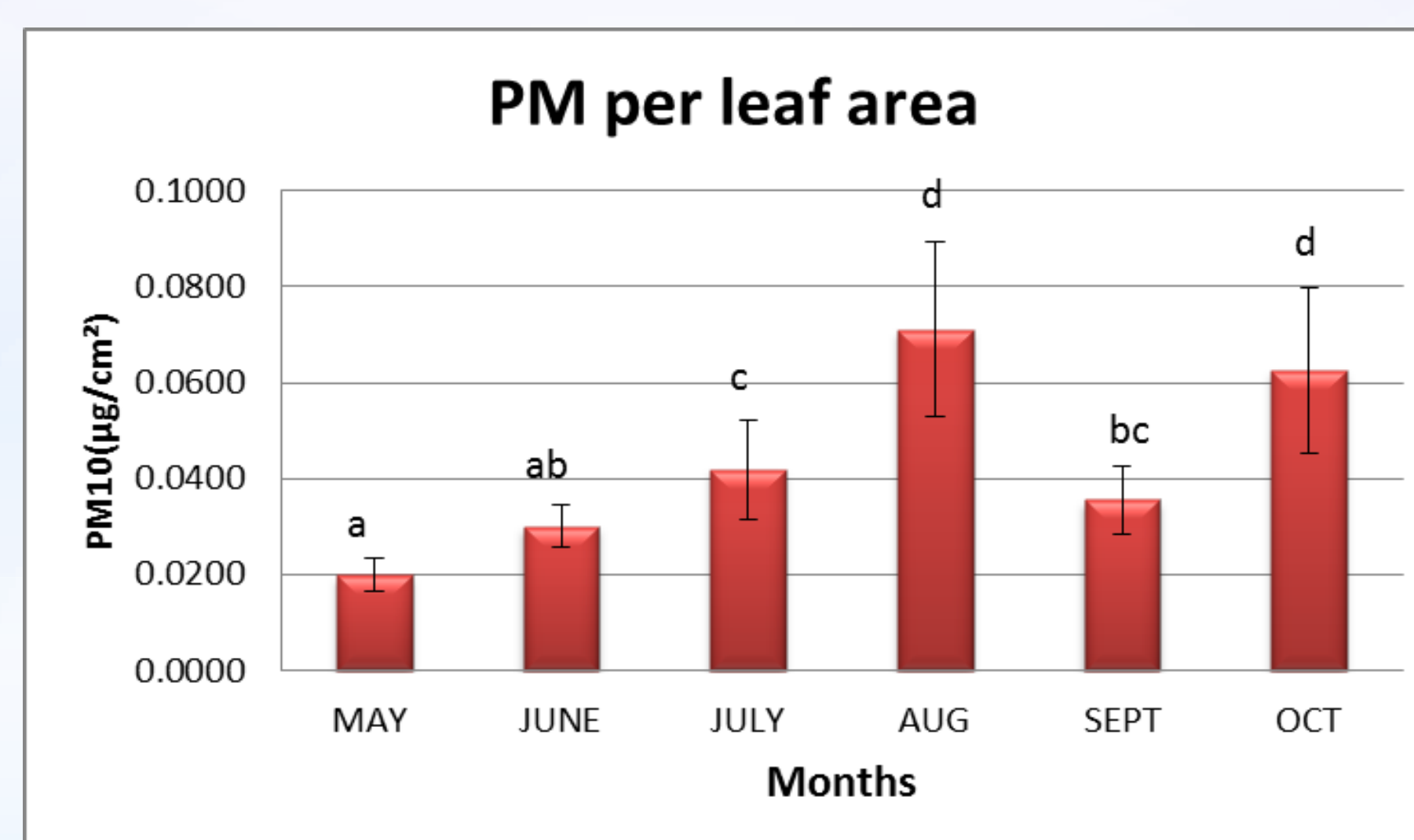


Figure 2: PM10 concentrations per month

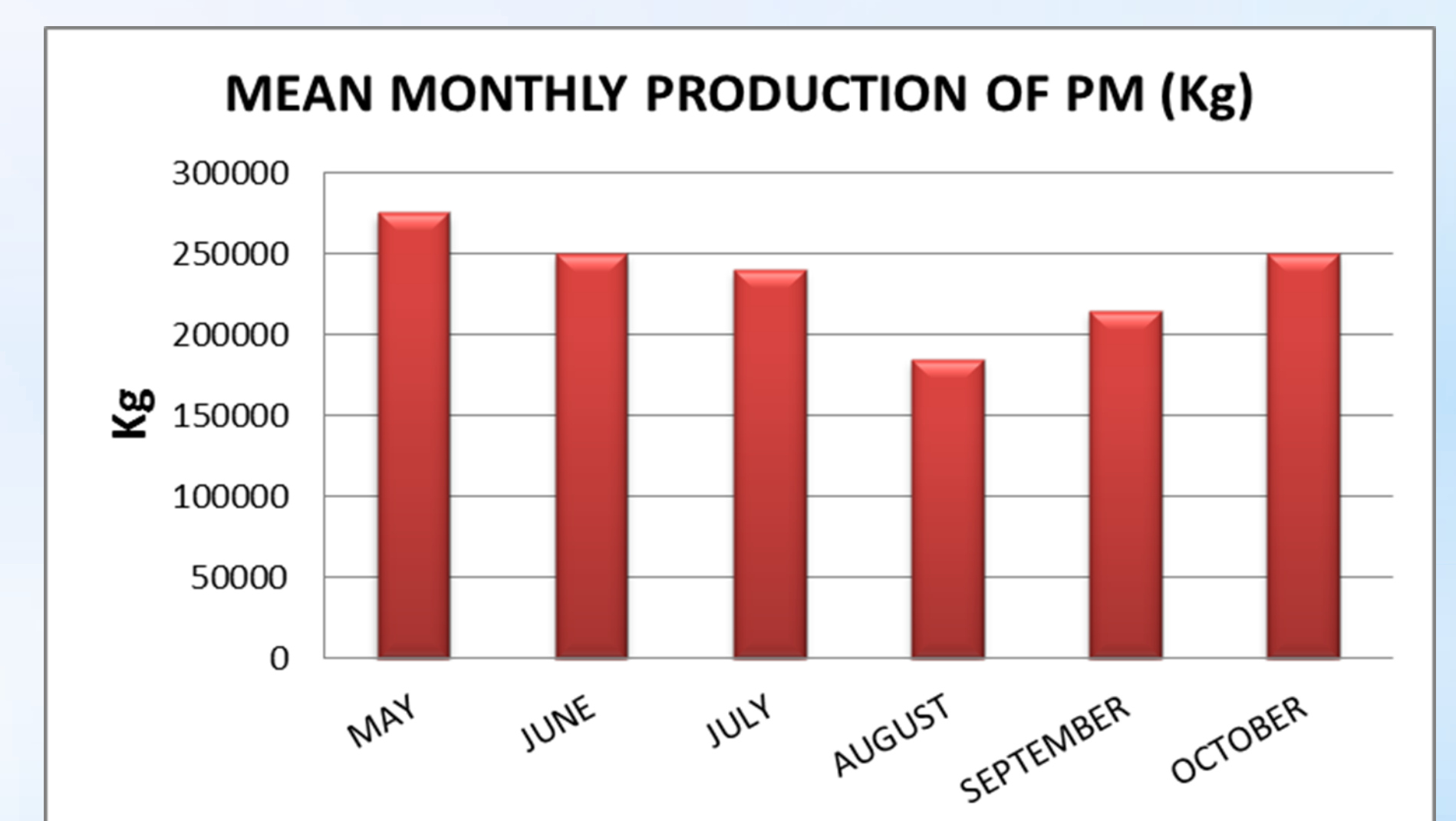


Figure 3: Mean monthly production of PM10

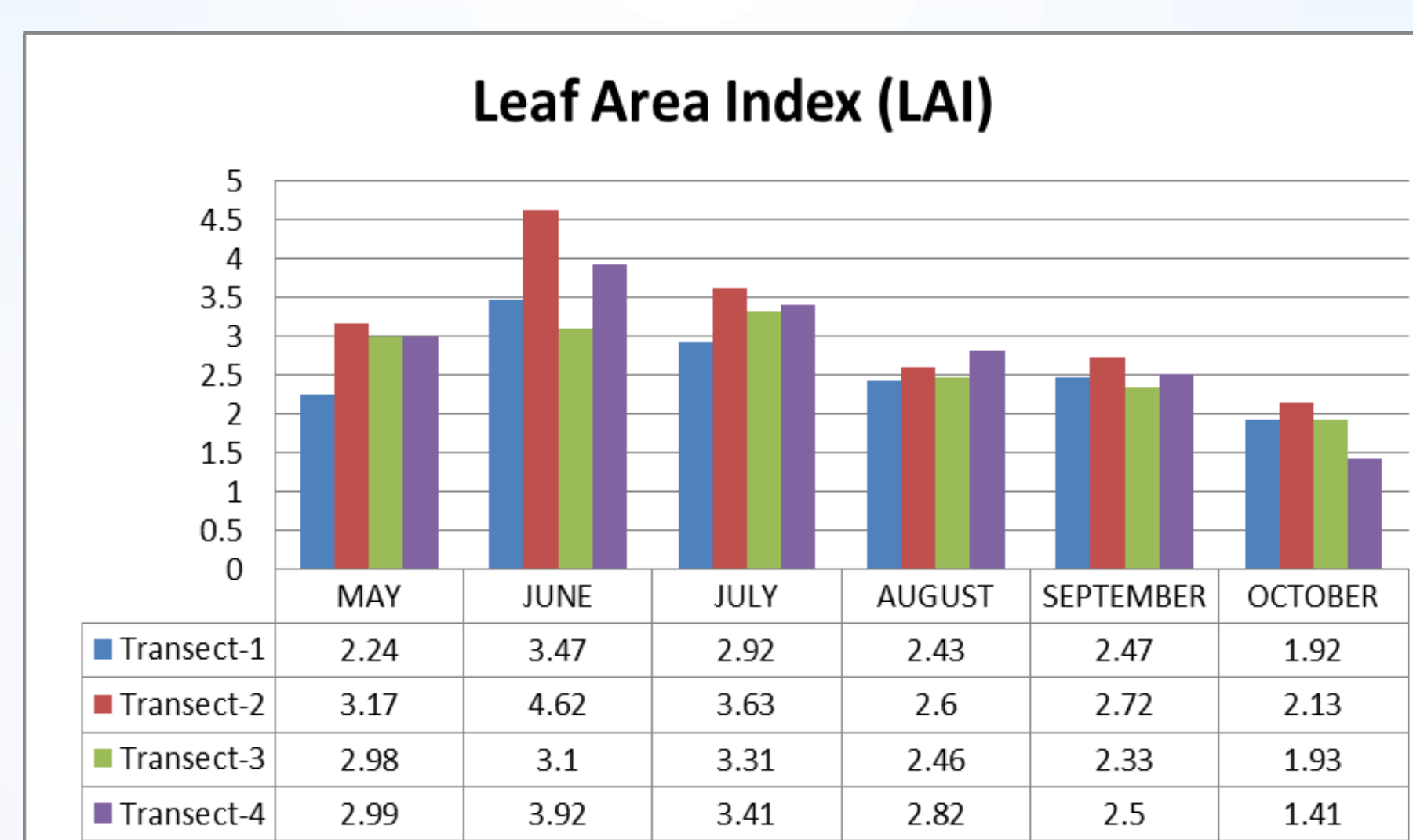


Figure 4: Leaf Area Index for each month

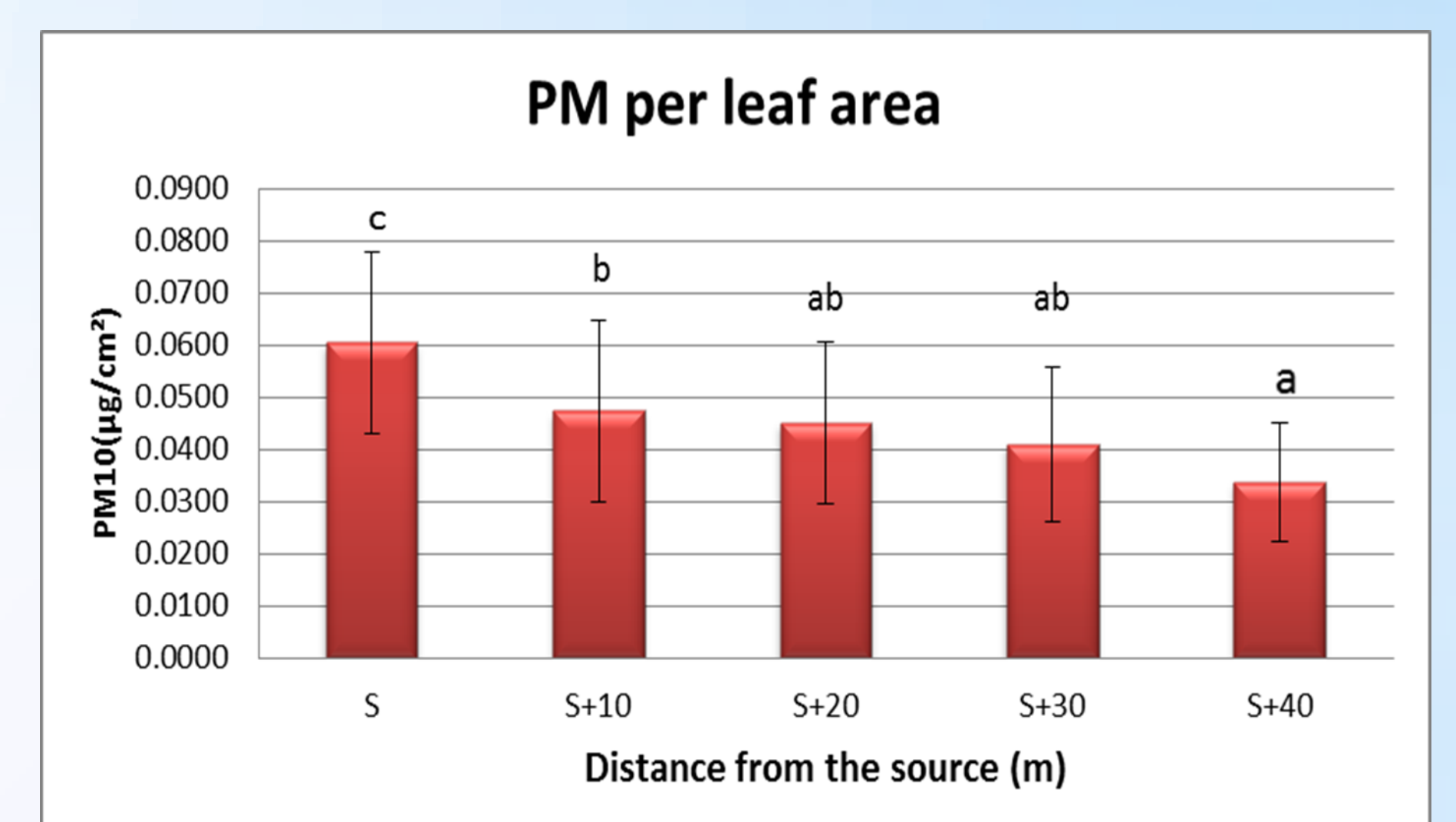


Figure 5: PM10 concentrations per distance from the source

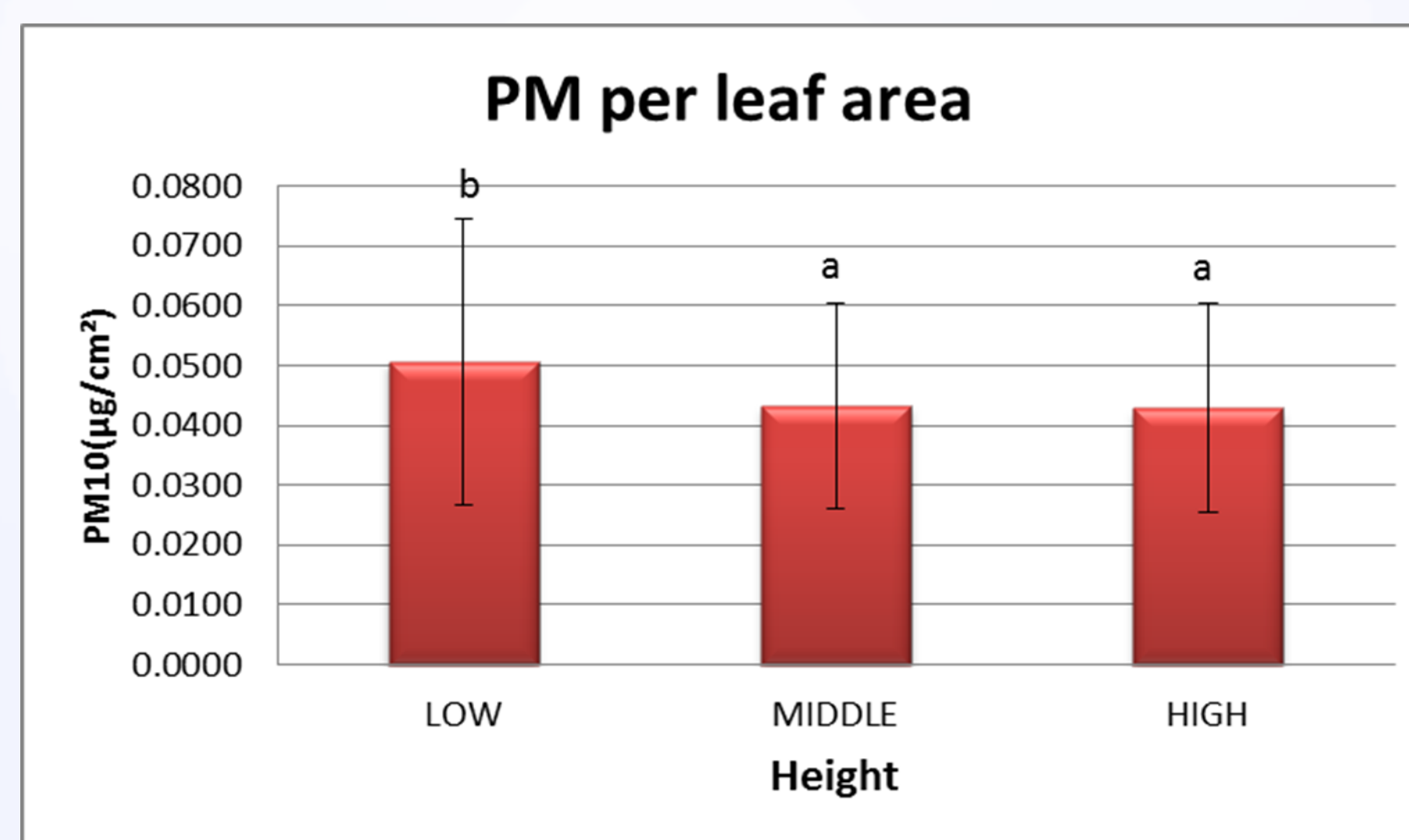


Figure 6: PM10 concentrations per height

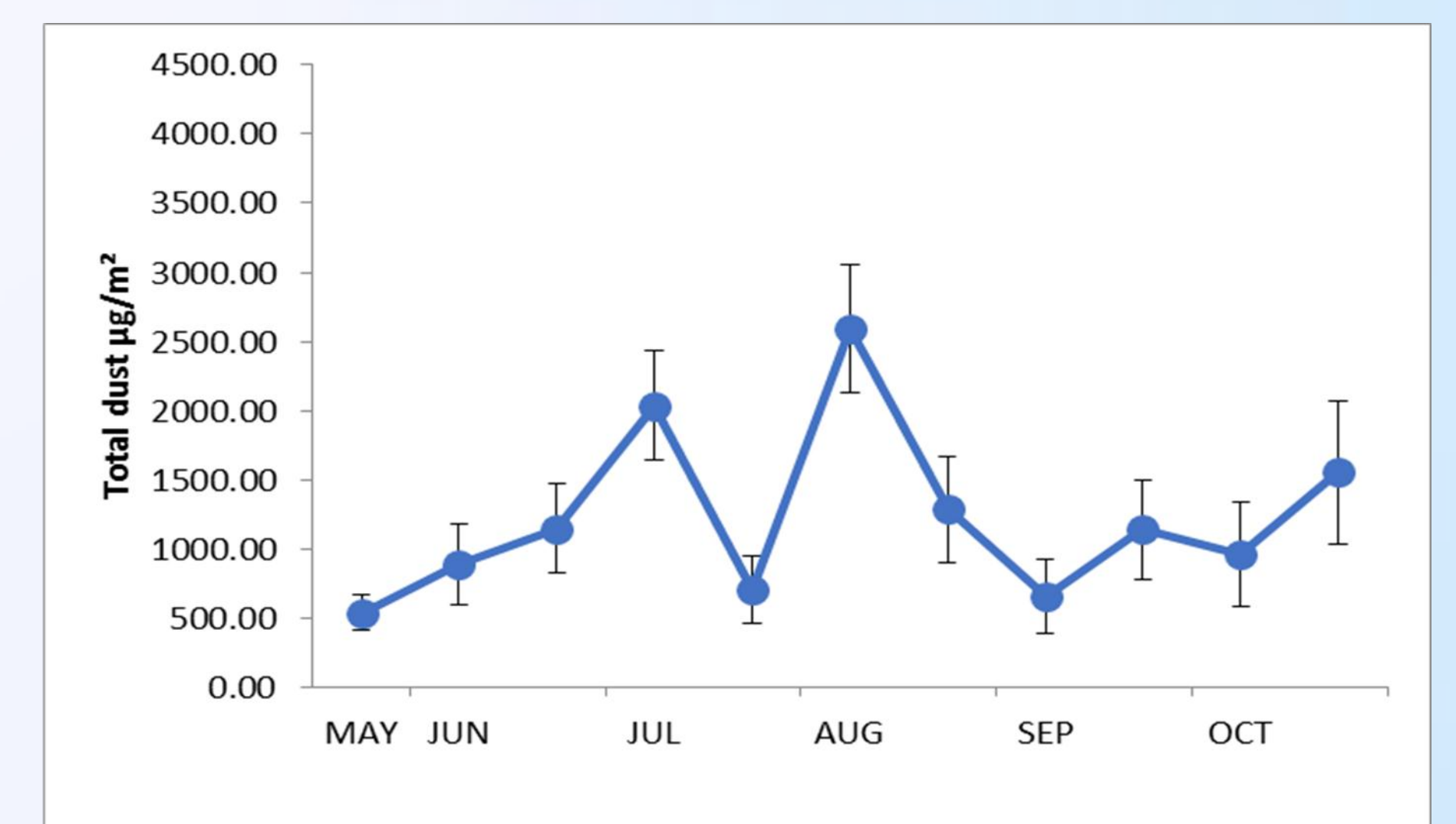


Figure 7: Total seasonal PM10 retention over the entire study area

4. Conclusions

- There is a considerable retention of PM10 by the foliage of the studied restoration plantations of black locust, which is mostly affected by the season of the year. This seasonality is not due to the respective production of PM10 or the phenology, as expressed by the LAI.
- The distance from the source of PM10 production and the position of the leaves within the trees canopy do not affect the PM10 retention efficiency.
- Future analysis will focus on the evaluation of meteorological effects and on the assessment of PM10 retention with the use gradients with higher spatial distribution.