Effect of Different Green Space Types on PM10 Concentration in Air
- Taking the Campus of Hunan University of Science and Technology as an Example

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Abstract. The daily and monthly weather changes of PM10 in different types of green space on campus were detected, and the effects of different types of green space on PM10 concentration were compared and analyzed. The results showed that the effects of different green space types of PM10 were significant in one day, but not in one year. At the same time, seasons have a significant effect on the air PM 10 concentration. Green space types have a significant effect on PM 10 concentration on one year.

1. Introduction

With the rapid development of cities and the continuous increase of industry, a large number of vegetation-covered lands has been replaced by buildings and roads, resulting in a decline of surface adsorption capacity, the reduction of dust filtering capacity, the increase of population and motor vehicles. Energy consumption and waste gas pollution are becoming more and more serious.

The existence of air particulate matter has a serious impact on people's production and living standards. Particulate matter with aerodynamic diameter less than 10 ums is PM10. PM10, also known as enabling particulate matter, is a kind of particulate matter that can float in the air in a long time. It has become one of the main pollutants affecting the urban living environment and the health of residents. The study of atmospheric particulate matters composition and the search for effective reduction of atmospheric particulate matter have become a research direction. However, there are few studies on the impact on landscape plants on PM10 in the air, especially on the relationship between PM10 concentration and green space types based on long-term monitoring in suburban areas. Greenland is a natural component of urban system. Garden plants, whose leaf surfaces structure and secretion determine that plants have strong dust retention ability [1]. A large number of research data show that there are great differences in the adsorption capacity of plants to PM10 [2]. Under the action of gravity and wind, dust can settle on the surface of plants, and plants can achieve dust retention effect on the interception and adsorption of dust by their branches and leaves [3]. So plants are called natural air filters [4].

In conclusion, green vegetation plays an irreplaceable role in reducing ambient air particulate matter. Some scholars have done a lot of work in using green plants to purify water and air, especially in absorbing indoor formaldehyde pollution. In terms of time span, the study on the relationship between garden green space and air particulate matter mainly focuses on a certain period of time or some seasons, lacking continuous monitoring and analysis throughout the year [5]. Therefore, it is of great theoretical and practical significance to study the relationship between PM 10 concentration and green space types.
and the law of monthly and daily changes throughout the year for the rational planning of green space and the construction of a good human settlements environment.

2. General situation and Research methods of Research area

2.1. General situation of study area

The research area is located on the campus of Hunan University of Science and Technology, and the environment is similar. Hunan University of Science and Technology (Hunan University of Science and Technology) is located in the middle subtropical monsoon humid climate, located in the suburbs of Xiangtan City. The experiment selected open land and 6 types of green space, and set up seven experimental sites, namely: control (CK), lawn (T1), shrub lawn (T2). The experimental plots of broad leaved Arbor (T3), broad leaved Arbor shrub (T4), coniferous Arbor (T5) and coniferous Arbor shrub (T6) were summarized as follows: (1) Turf area was 1500 m², and grass species were Zoysia tenuifolia. The coverage rate was 90%. (2) The area of shrub lawn is 3000 m², Zoysia japonica, Loropetalum rubrum and Ligustrum microphylla are planted according to their niche. The coverage rate was 99%. (3) The area of broad leaved Arbor is 2000 m², and the main tree species are Osmanthus. Magnolia bicolor and Magnolia magnolia were mixed. There were POA pratensis, barnyard grass and so on under the forest. The coverage rate was 80%, the height of Osmanthus was 10m-13m, the diameter of breast height was 15cm-20cm. The canopy density is 95%. (4) The broad leaved Arbor and shrub area is 1hm². It is the community pattern of subtropical evergreen and Ye Lin. The main tree species are camphor, du Ying and bamboo cypress, shrubs include Ligustrum lucidum, Gardenia jasminoides, Nandina, and so on. Under the forest, bluegrass, rosegrass, barnyard grass, and so on. The canopy density is 99%. (5) The area of coniferous herbage is 1000 m². The tree species are cedar, height 15m-20m, the diameter of breast height is 20cm-30cm. The canopy density is 67%. The understory grass, phiopogon japonicus and entucky bluegrass, The grass cover rate is 80%. (6) The acreage of coniferous trees and shrub grass is 600 m², which is a typical plant community of coniferous tree and shrub grass combination. The canopy density is 90%. (7) The control point was located in the open field, which was far away from the green land without plant cover, with an area of 6000 m².

2.2. Research Methods

From June 2013 to May 2015, the project continued to collect and collate information on the subject of the study, through the following.

2.2.1. Study on the diurnal variation of different Green Space types

From 8:00 to 20:00 in Beijing time, the concentrations of PM10 were measured from 8:00 to 20:00 in September 2014 and May 2015 respectively, and three data were measured in each experiment. The diurnal changes of PM 10 were recorded scientifically.

2.2.2. Study on monthly variation of different Green Space types

The air PM10 concentrations were measured and recorded from 8:00 in the middle and late days of each month. Three data were measured at different locations in the same experiment. The monthly variation of PM 10 was obtained. In order to study whether different types of green land have significant effect on PM 2.5 in the whole year, the variance analysis of PM 10 in experimental and control areas was carried out within one year.

2.2.3. Study on the variation Law of different types of Green Space under different Weather conditions

On the campus of Hunan University of Science and Technology, the typical weather conditions of May 12, 2015 and May 13, 2015 are used to measure the PM10 concentrations at the same time in each experimental place, respectively. The experimental instrument used in this experiment is a high-precision hand-held PM2.5 speedometer provided by Sinawi Environmental Technology Co., Ltd. The sampling height is 1.5 m from the ground.
3. Results and analysis

3.1. Diurnal variation of PM10 in different Green Space types

The mass concentration of PM10 decreased rapidly from 08:00 to 10:00, decreased steadily in the period of 10:00-14:00, continued at a stable stage at 16:00-18:00, and reached 18:00. The concentration of PM10 began to rise and the trend continued until 20:00. At 8:00 in the day, PM10 was the highest, the lawn reached 125 μg/m³, and 18:00, the lowest was 35.67 μg/m³, and the lowest PM10 was 48 μg/m³ at 16:00, the rate is 24.3% higher than the lowest value of coniferous trees at this time. At 20:00, the PM10 of the control area rose rapidly to 83 μg/m³, with a growth rate is 30.4%. The results of variance analysis showed that the difference of PM10 in different time was significant, and the difference of different greenbelt type was different. The difference between grass and shrub lawn was similar to that of broad-leaved arbor, broad-leaved arbor shrub and coniferous arbor. There were significant differences among the four types of green land, but there was no significant difference between broad-leaved trees and conifers. The PM10 error is controlled from 2% to 8%. During the observation period, PM10 is lower than the Ambient air quality standards (GB 3095-2012), which accords with the standard of residential area and cultural area [6].

![Daily variation of air PM10 concentration in different greenlands](image)

Fig 3.1 Daily variation of air PM10 concentration in different greenlands

3.2. Variation of PM10 under different types of Green Space and different Weather conditions

Also taking the observed data from the typical weather conditions of May 12, 2015 and May 13, 2015 on the campus of Hunan University of Science and Technology as an example, the mass concentration of PM10 in rainy days is much higher than that in sunny days. The mass concentration of PM10 in rainy days is 132%-335% higher than that in sunny days. The highest value of conifer was 225 μg/m³, while the lowest was 149 μg/m³ in lawn. On sunny days, the highest mass concentration of PM10 was 64 μg/m³, while the lowest of conifer was 33μg/m³. In general, except for lawn, the mass concentration of PM10 fluctuated the standard value of the World Health Organization (WHO) from 3 to 6.67 in sunny days. Most of them exceed the World Health Organization (WHO) guidelines of 50 μg/m³ and are well below the Ambient air quality standards (GB 3095-2012). In rainy days, the mass concentrations of PM10 were significantly higher than those of the World Health Organization (WHO), except that the lawn was slightly lower than the Ambient air quality standards (GB 3095-2012), with the exception of the lawn 149μg/m³, which was slightly lower than the Ambient air quality standards (GB 3095-2012). Others were above the Ambient air quality standards (GB 3095-2012).[8] The order of PM10 concentration in rainy days was coniferous arbor shrub > broadleaf arbor > conifer > shrub lawn > control group > lawn.
3.3. Monthly variation of PM10 in different greenbelt types

The change trend of air PM10 mass concentration in different greenbelt types is basically the same, the PM10 in September is the lowest, the PM10 in January is the highest, and the other months are between the highest and the lowest. The results showed that there was no significant difference in the mass concentration of PM10 between February, March, May, June, July, August, November and December, and there was no significant difference between April and October, and there was no significant difference between April, May, June and December. There were significant differences between the two groups in January and September. In order to study whether different types of green space have significant influence on the PM10 concentration in the whole year, the variance analysis of PM10 mass concentration in the experimental area and the control area was carried out within one year. The results showed that different types of green space had a significant effect on PM10 concentration in one year. Among them, shrub lawn, broad-leaved Arbor shrub, coniferous Arbor shrub and broad-leaved Arbor had significant difference, but with lawn, control, the monthly average value of PM10 concentration was as follows: broad leaf arbor grass > lawn > control group > conifer grass > shrub lawn > broad-leaved arbor shrub > coniferous shrub grass. The PM10 mass concentration fluctuated greatly with the month. In order to better understand the variation rule of PM10 mass concentration, by integrating the data of processing, the variation of PM10 mass concentration with seasons and different grassland types was obtained by multiple analysis. There were significant differences in PM10 mass concentration among different green land types. The weight concentration of PM10 in autumn < summer < spring < winter, autumn, summer and spring were not obvious, but the difference between summer and spring was obvious.
4. Conclusion and discussion
In this paper, PM10 in lawn, shrublawn, broadleaf arbor grass, broad-leaved arbor shrub grass and coniferous tree shrub grass was studied in different time and different greenbelt types. The effects of different weather conditions on PM10 are analyzed. The conclusions are as follows:
Within one day, the concentration of PM10 was significantly different in different time periods. The diurnal changes of PM10 were higher in the morning and evening and lower in the daytime. This is consistent with the conclusion of Zhiping Wu that study[10]. PM 10 are in the best state of the day in the period of 16:00-18:00. At 08:00 in the morning is higher than at 20:00 in the evening. This is contrary to the conclusion of Zhiping Wu which study[10], which may result from the temperature difference between the north and south.

Within one day, the effect of different types of green space on PM10 concentrations was significant. PM 10 concentrations in 6 different types of green space was consistent: coniferous tree shrub < coniferous herbage < broad-leaved herbage > broad-leaved herbage. leaf arbor < shrub turf < control group < turf. Compared with the control, the average decrease of PM10. Concentration in different types of green land was as follows: coniferous and broad-leaved Arbor shrub and broad-leaved arbor irrigated with 32%, coniferous arbor was 31%, broad-leaved Arbor was 28%, shrub lawn was 17% and lawn was 7%. The average decrease of PM 10 in different types of green land was 32% for coniferous trees, 28% for broad-leaved trees, 23% for broad-leaved Arbor, 16% for shrubs and 9% for lawn. The effects of different types of green space on PM10 were significant in one day, but not in one year. This was consistent with the study of, Wang Cheng and Yang Weiwei[11]. The concentration of PM10 in this study was the highest in January. The maximum discrepancy with PM10 in April may be related to the difference of climatic conditions in the geographical location of the study area.

In the study of the effects of different types of green space on particulate matter in the air, it was found that the adsorption of particulate matter in the air by the more complicated types of green space, such as arbor, irrigation and grass, was stronger than that of the greenbelt with a single structure or control. However, when it comes to high temperature and high humidity, there is no plant control with high air particulate content, which is consistent with the study of Sun Shuping, Gu Runze, and Zhang Jing[12].

Acknowledgment
Fund Project: Excellent Youth Project of Hunan Provincial Department of Education (17B098); Teaching Reform Project of Hunan Provincial Department of Education (373)
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