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"Oxygen Factory" at the CSU Carbon Farm them A. A. Kadyrov

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Abstract. This paper presents studies carried out at the carbon farm of the ChSU named after A.A. Kadyrov from April to November 2022 in order to identify factors affecting CO2 fluxes in different environmental conditions. On the territory of the carbon farm, where paulownia was planted, CO2 emissions were measured, air temperature, temperature and soil moisture were simultaneously recorded. Soil samples of 0-10 cm layers were taken. Field methods of analysis were carried out by the chamber method, gas analyzer LI-COR - 7810 in the area where the foundations were installed in the amount of 10 pieces.

1 Introduction

Carbon farms or we can give another name, carbon farms are areas where special technologies increase the absorption of carbon dioxide and produce carbon units. In order to offset greenhouse gas emissions into the atmosphere, they have to be bought by industries that cannot switch to carbon-neutral products.

At the carbon farm of the carbon polygon of the ChSU named after. A.A. Kadyrov in 2021 were planted: paulownia and poplars of various species. In this article, we will consider only paulownia.

Paulownia is a fast-growing tree, considered to be an “oxygen factory” [1]. On the territory of the carbon farm, paulownia was planted on an area of 3.1 hectares in October 2021 (Fig. 1, Fig. 2), which has an absorption capacity approximately 15-20 times higher than that of pine [1].

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Fig. 1. Paulownia before landing

Fig. 2. Paulownia after landing

After pruning, many new shoots form on the stump (Fig. 3). Paulownia leaves contain 20% protein in the green form and 13% in the leafy form. The highest percentage of protein is found in annual plants.

Fig. 3. Paulownia after pruning, May 10, 2022

New shoots after pruning grow with cosmic speed and in a few years form a full-fledged tall tree (Fig. 4). In May, the height of the shoots was 25-30 cm. And in September-October, the height of the trees already reached 2.5-4 m (Fig. 5). This once again indicates that the tree is indeed fast-growing.

Fig. 4. Paulownia, August 2022

Fig. 5. Paulownia, September 2022

2 Materials and Methods

The urban ecosystems of Grozny belong to the plain territory, the height above sea level is 120-170m. The background soil for the site are southern chernozems and ordinary micellar-carbonate. This can be seen on the soil map (Fig. 6) [2].

After planting trees on the territory of the site, soil samples were taken (Fig. 7), which showed that the soils on the carbon farm site were agro-chestnut. The upper horizon of carbonate chernozems contains from 4 to 9% humus. They have large reserves of basic nutrients, and yet they are not enough for the life of vegetation.

After planting trees on the territory of the site, soil samples were taken (Fig. 7), which showed that on the site of the carbon farm, the soils are agrokastan. The upper horizon of carbonate chernozems contains from 4 to 9% humus. They have large reserves of essential nutrients, and yet they are not enough for the vital activity of vegetation.

Fig. 6. Fragment of the soil map

Fig. 7. Soil sampling, March 2022

To study CO2 emissions on a carbon farm (the Campus of the A.A. Kadyrov ChSU), field methods were used, using a closed chamber method, using a LI-COR - 7810 mobile gas analyzer (Fig. 8).

Fig. 8. LI-COR - 7810 mobile gas analyzer on a carbon farm

In the period from April 20 to October 24, 2022, three main greenhouse gases (carbon dioxide, methane, water) were measured. On a carbon farm site, at a depth of 2-3 cm, 10 bases (d= 200 mm) were installed for greenhouse gas measurements (Fig. 9). The bases were located: odd values of the study points - the inter-crown space, even - under the crown of trees (Fig. 9, 10). The distance between the bases was 10-15 m, the distance between rows and trees was 4 m (Fig. 11). Measurements of CO2 emissions from the soil were carried out in the morning from 9.00 to 10.00. Before taking measurements, aboveground vegetation was cut from the soil surface. The rate of CO2 release into the atmosphere from the soil was calculated by a linear increase in the concentration of gas in the air of the chamber after its closure in the interval from 30 to 40 seconds. At the same time, the gas analyzer recorded the temperature and humidity of the soil in layers of 0-10 cm.

Fig. 9. The base under the crown

Fig. 10. The inter-crown installation of the bases

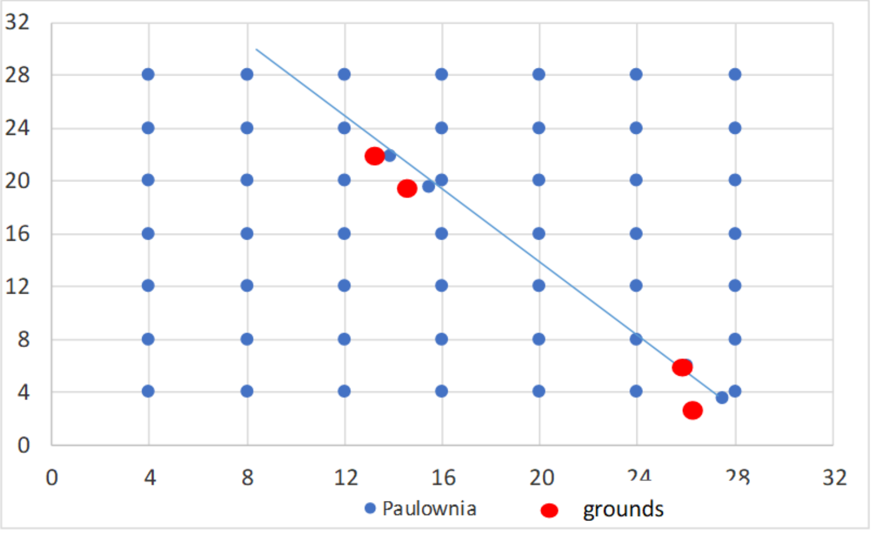

Fig. 11. Scheme of installation of bases for measuring greenhouse gases

The location of the bases was not taken by chance. The climate of the studied area is continental. Natural irrigation for Paulownia in this part of the climatic zone is not enough. Drip irrigation was organized on the site of the carbon farm. The grounds were decided to be installed so that it would be possible to monitor CO2 emissions in places with and without irrigation (natural irrigation). Drip irrigation was carried out from May to September. Changes in soil moisture at the bases with drip irrigation and natural irrigation are reflected in the graph (Fig. 13).

For monitoring in the article, we used the data of base 6 – under the crown (with constant irrigation) and base 7 (only natural irrigation) – the inter-crown space.

The results of the studies are presented in Table 1, and are also reflected in the graphs (Fig. 12, 13)

Table 1. Studies conducted in the period from April to October 2022

Vegetation	Carbon stocks, umol/m2/s	Change in the average monthly air temperature °C during the study period	Change in average monthly soil moisture
Paulownia, the foundation 6	0,09-1,28	11,3-27,5	15-36,7
Paulownia, the foundation 7	0,53-2,32	11,3-27,5	15-36,7

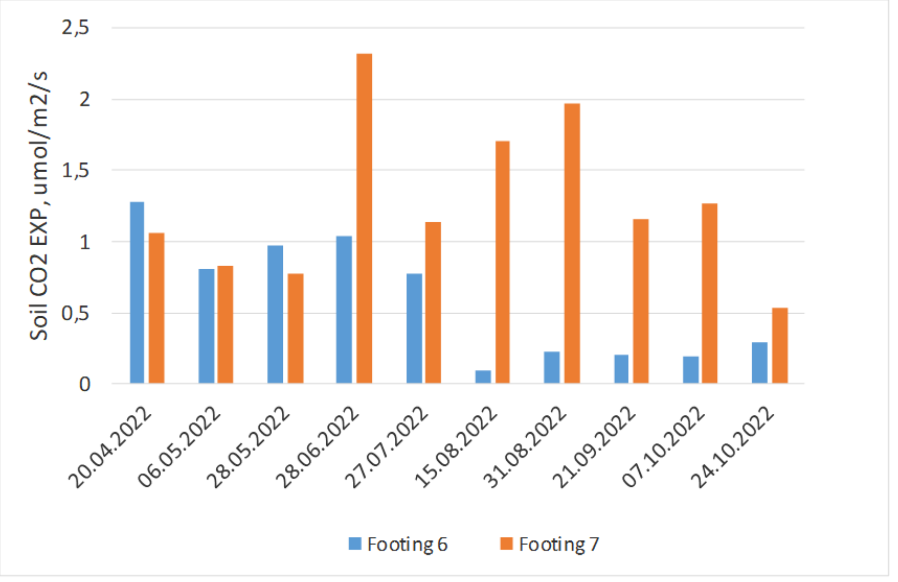

Fig. 12. CO_2 measurements on a carbon farm from April 20 to October 24, 2022

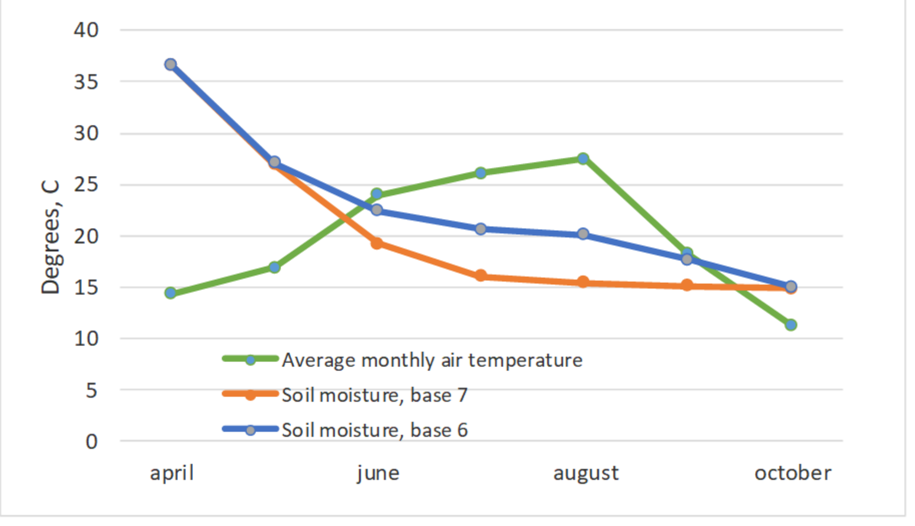

Fig. 13. Changes in atmospheric air temperature and soil moisture from April to October 2022

In addition to field studies, data from the weather station, which is located on the territory of a carbon farm, was taken into account when drawing up the schedule (Fig. 14). The weather station "Infometeos" automatically records data on air temperature, soil, humidity, wind flows and other parameters.

Fig. 14. «Infometeos» weather station

3 Results and discussions

The balance between the absorption of carbon dioxide by terrestrial vegetation (to create organic matter) and the release of carbon dioxide determines the carbon cycle in terrestrial systems during soil respiration. Carbon dioxide of the atmosphere is 90% of soil origin, which implies what a powerful source of carbon dioxide, is the soil cover of the Earth [3].

The observations have shown a statistical relationship between carbon dioxide emissions, air temperature, soil humidity, and soil temperature is the subject of correlation and regression analysis. Correlation analysis gives us the relationship between the values and how strong it is. By constructing a model (regression model), we obtain a more accurate mathematical description, i.e. regression analysis.

From the observations obtained, it can be concluded that the CO2 reserves in base 6 changed during the study period from 0.09 to 1.28 umol/m2/s, the average monthly temperature from 11.3 to 27.5 0 C, soil moisture from 15 to 36.7%. Having considered base 7, we can say that during the study period, CO2 reserves changed from 0.53 to 2.32 umol/m2/s, the average monthly temperature from 11.3 to 27.5 0 C, soil moisture from 15 to 36.7%. The graph shows (Fig. 12) a noticeable decrease in CO2 emissions since June.

The highest emission was observed during the growing season in the inter-crown space, the concentration of which was 2.32 umol/m2/s. If we consider the space under the crown, then the highest value is observed in April, which was 1.28 umol/m2/s. In the rest of the period, the values did not exceed the readings of 1.04 umol/m2/s. According to the author, there is a direct relationship between the temperature of the air, soil and constant artificial irrigation.

It is also necessary to take into account that microorganisms [4] provide half of the CO2 flow, and the transformation of terrestrial ecosystems is accompanied, most often, by deterioration of their functioning and loss of organic carbon reserves [5]. Here we can observe a direct relationship between CO2 emissions and microbial indicators. CO2 emissions at this site can be explained by the rate of microbial respiration and different irrigation methods.

4 Conclusions

In the period from April to October 2022, the CO2 emissions of the soil were assessed at the Paulownia planting sites, where southern and ordinary micellar–carbonate chernozems are located. CO_2 emissions from soils are low, but significant seasonal dynamics of CO_2 emissions determined by hydrothermal conditions have been revealed. The interrelation of emission activity in the areas established by the base under the crown of trees, the inter-crown space and natural and artificial irrigation of the soil is revealed. In areas with artificial irrigation, carbon emissions are detected below.

References

1. M. Karmakova. Forest complex (2021).
2. Soil map of the Chechen Republic (1978).
3. National Atlas of Russia, **2** (2021).
4. S. V. Sushko, N. D. Ananyeva, K. V. Ivashchenko, V. N. Kudeyarov, CO_2 emission, microbial biomass and basal respiration of chernozem under different land use. Soil Science, **9**, 1081-1091 (2019).
5. A. Tembo, M. Samardzhich, V. I. Vasenev, O. V. Ryzhkov, D. V. Morev, I. I. Vasenev, Analysis of the main factors affecting the soil emission of carbon dioxide by the chernozems of the Streletskaya steppe, Modern problems of science and education, **2** (2014).
6. G. Plancque, D. You, E. Blanchard, V. Mertens, C. Lamouroux, Role of chemistry in the phenomena occurring in nuclear power plants circuits, Proceedings of the International Congress on Advances in Nuclear power Plants, ICAPP, 2-5 May 2011, Nice, France (2011).