Investigation of the intensity of carbon dioxide emissions by steppe soil when introducing fallow lands into circulation

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Abstract. The paper reflects the results of studying the temporal variability of carbon dioxide fluxes by the soils of deposits when they are introduced into agricultural circulation. The purpose of the research is to study the change in carbon dioxide emissions by the soils of fallow lands in the conditions of the steppe of Western Siberia. In 2022, research was conducted in the Omsk Region at key sites. The soils of the site are solodic, malodorous medium low-sodium columnar heavy loamy meadow-chernozem; cortical columnar heavy loamy saline meadow-chernozem, fine-grained low-humus heavy loamy meadow malt. Seasonal changes in carbon dioxide fluxes by soils on deposits when introduced into circulation using agrotechnical technology are significant (Figure 2) with a maximum in July (67.7 g CO₂/m²/day) and a minimum in September (16.7 g CO₂/m²/day); on deposits with combined technology, respectively, 54.4 and 14.1 g CO₂/m²/day. Agrotechnical technology contributed to a greater emission of carbon dioxide from the soils of the deposit than combined. The system of agrotechnical techniques when introducing fallow soils into agricultural circulation has a significant impact on the release of carbon dioxide by the soil surface. Of the soil level of the deposit without treatment, it was 162% with agrotechnical technology (tillage), and with combined (tillage + herbicide application) 133%.

1 Introduction

An element of the national security of any state is to ensure its food security [1-2]. In Russia, the fundamental direction in ensuring food security is the introduction of abandoned agricultural land into circulation [3-4]. The modern climate agenda has actualized the study of the intake of greenhouse gases into the atmospheric air during various types of human activity, and primarily in the process of agricultural production [5-6]. Fallow lands are a significant reservoir for the accumulation of greenhouse gases. But when they are introduced into agricultural circulation, the emission of carbon dioxide (CO₂) from soils, according to numerous data, increases, which requires detailed study. Given the high degree of uncertainty of estimates of biogenic greenhouse gas emissions [7-11], it is necessary to...
Develop a system for monitoring emissions on fallow lands depending on the natural zone, relief elements, soil cover, as well as technologies for their introduction into circulation. This will make it possible to clarify the overall estimates of the contribution of soil deposits to emissions and make decisions on the management of carbon deposition and balance.

The purpose of the research is to assess the carbon dioxide emission by the soils of fallow lands when they are introduced into agricultural circulation in the conditions of the steppe of Western Siberia.

2 Materials and Methods

Studies have been conducted on the study of various agricultural technologies for the introduction of fallow lands into circulation. The territory of the steppe zone site (Cherlaksky district of Omsk region) is confined to the geomorphological area of the Kurumbel depression, which is part of the West Barabinsk Pliocene-Quaternary denudation-accumulative plain. The experiments were laid on 5-10 summer fallows.

During the survey of the soils of the deposit site, meadow-chernozem solonetz was found to be rejuvenated, medium low sodium columnar heavy loamy; meadow-chernozem cortical columnar heavy loamy solonetz, as well as meadow small-grain low-humic heavy loamy malz.

Solonets meadow-chernozem rejuvenated contains Sorghum in the mountains. А1, 13,42, В1–1,46%; exchange-absorbed Ca2+ - 11,9 and 12,5, Mg2+ - 11,9 - 10,0, Na+ - 0.76 and 1.77 mmol/100 g, respectively. The pH of horizons А1 and В1 was 5.90 and 6.30, in B2 – 7.15, in mountains. B3k-Sk – 9.0 – 9.14.

The vegetation of the deposit is represented by false sheep fescue, meadow bluegrass, creeping wheatgrass, boneless stalk (rarely), saltpetre wormwood, goose's foot, yellow bedstraw, veronica paniculata, tuberous zopnik, salt marsh aster, flat blueberry, gray-green hiccup, feathery feather grass, common strawberry, five-lobed motherwort, thyme, labaznik vyazolistny, yarrow white, meadow foxtail, medium plantain. The vegetation condition was depressed due to the drought. The value of the aboveground air-dry phytomass is 0.59 - 1.78 (on average 1.03) t/ha.

The first system of agricultural practices when introducing fallow lands into circulation provides only agrotechnical treatments, the second, with the use of herbicide (combined).

Scheme of the field experiment:
1. A fallow land without treatments.
2. Agrotechnical technology of introduction into circulation. The main tillage: disking with a BDM 7x2P diskator + the second treatment: with a BDM 7x2P diskator to a depth of 12-15 cm.
3. Combined technology of introduction into circulation. The main tillage was carried out with the BDM 7x2P discator to a depth of 10-12 cm + the second treatment (chemical) with the herbicide “Glyphosate” at a dose of 2 l/ha.

The first treatment was carried out on 18.07, the second – on 8.09.2022. The area of plots is 200 m².

Carbon dioxide emissions were determined from July to September. The repetition is threefold. Sampling of gas samples for carbon dioxide content in the chambers was carried out with an air sampler in glass vials (volume 30 ml) during the day (24 hours) every three hours. The samples were analyzed using a Crystal 5000.2 gas chromatograph.

Soil temperature was determined by thermometers, soil moisture by the weight method, indicators of soil properties by standard methods.
3 Results

The emission of carbon dioxide by the soils of deposits is a parameter, the value of which largely depends on the soil, weather, time of year and day, the system of agrotechnical techniques [16-21].

The daily changes in the emission of carbon dioxide by soils for fallows when introduced into circulation using agrotechnical technology in September ranged from 10.6 to 15.5 g of CO₂/m²/day; for fallows when introduced into circulation using combined technology from 7.9 g to 11.9 g with a higher intensity of carbon dioxide release from the soil surface in the morning and afternoon and smaller in the evening and at night (Figure 1). It should be noted that only in September, agrotechnical techniques differed when introducing deposits into circulation, therefore, differences in the magnitude of carbon dioxide fluxes were noted.

Fig. 1. Daily changes in carbon dioxide emissions by soils during the introduction of fallow soils into agricultural circulation in the steppe.
4 Conclusion

5 Acknowledgments
References

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