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INTENSITY OF RESPIRATION AND EMISSIONS OF CO_2 FROM SOD DEEP GLEYIC SOIL DEPENDING ON THE PRODUCTIVITY OF GREEN MANURE CROPS

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The research was conducted in the Botanical garden of Zhytomyr National Agroecological University on sod deep gleyic medium loamy soil. Determination of the intensity of respiration CO_2 and emissions of soil was carried out on the basis of chamber static method with an infrared sensor. The approaches to assessing of soil respiration were described, depending on the productivity of green manure crops in the Polissya of Ukraine.
A number of green manure herbs on the index of intensity of soil respiration (IDH) (mg/m^2/minute) was determined, namely: *Rafanus sativum var. Oleifera* 73,7 → *Pisum arvense L.* 42,0 → *Lolium multiflo* 39,2 → *Lupinus angustifolius* 35,6. The relationship between the intensity of soil respiration and the size of land mass of green manure crops in flowering phase was defined. The correlation coefficients (r) are: *Rafanus sativum var. Oleifera* 0,62 (medium degree), *Pisum arvense* 0.62 (medium degree), *Lolium multiflo* 0.46 (medium degree), *Lupinus angustifolius* 0.93 (very high degree). Ways of suspension of increasing CO_2 concentrations in the atmosphere.

Key words: *emission* of *CO_2, infrared sensor, green manure crops, intensity of soil respiration, organic matter*

Introduction. It is widely known that in recent years the trend of atmosphere CO_2 increase has resulted in the air temperature rising which, naturally, makes it one of the most actual problems of humanity. The problem being acute to the extreme the scientists all over the World are prompted to look for the efficient ways out of it.

Besides, the process mentioned above develops on the background of a constant degradation of soils and is caused to an extent by the intensification of their agriculture use. Thus, the ways of rational use of the soil as the general mean for crops production become most important in the context of global greenhouse effect problem.

Among the soils` characteristics those showing the soil functions play an important part by characterizing soils capacity or incapacity of sustaining the favorable conditions for crops productivity and quality of production.

With this the soil organic matter balance is considered as one of the key characteristics largely determining considerable number of the soil regimes [1-3]. The rates of the soil organic substance accumulation or dissipation depend upon a number of the time variables which frequently oppose each other with their balance-controlling trends either intensifying the organic matter production or, on the contrary, intensifying the processes of its destruction and mineralization.

That is why studies of the soil respiration as an integral part of the atmosphere carbon balance are one of the main subjects of researches for soil scientists, biologists and ecologists.

It is a well-known fact that CO_2 dissipation into atmosphere depends on quite a number of factors, that is the green manure grasses' features and the plants' over-ground mass and, consequently, their root mass and soil temperature and moisture content and so on [4-8 *et al*.].

The connection between the plants' over-ground mass and their root mass is of course indisputable. Consequently, when the plants' over-ground mass is to be assessed within the scope of any experiment their root mass must be estimated also, though indirectly and roughly.

The goal of this work was to find the general features of CO_2 emission from the deep sod gleyic middle-loamy soil under the green manure grasses in relation with the productivity of those.

Object of the researches – to determine a role the green manure crops play in the soil carbon regime and to find what kind of interconnection exists between the plants' over-ground mass and intensity of soil respiration in the form of an escape of carbon ($C\text{-}CO_2$).

Terms of the researches. Researches were carried out within the scope of the small-site experiment laid in the botanic garden of the Zhitomir National Institute for Agroecology Researches in 2013.

Number of replicas is six, site area is 2,1 m^2. Basic cultivation is tillage 20 sm deep. The grasses were sowed at 30.05.2013.

Crops under research were as follows:

- blue lupine (*Lupinus angustifolius*), "Victor" ("*Переможець*") variety;
- Austrian winter pea (*Pisum arvense L.*), "Zviagelska" («*Зв'ягельська*») variety, originator – "Institute for Agriculture of Wooded District" of UAAS;
- Italian ryegrass (*Lolium multiflo*), "Kiev"(«*Київський*») variety, originator – NSC "Institute for Land Use" of UAAS;
- oil radish (*Rafanus sativum var. Oleifera*), "Lybid" («*Либідь*») variety; originator – "National Botanic Gardens named after M.M.Grishko" of UAAS.

When measuring the emission rate ($C\text{-}CO_2$, mg/m^2/min) the values of ambient abiotic parameters (temperature and atmospheric pressure) were taken into account.

The measuring was carried out on a sunny weather at 14-00 every day: 2013 July 2 (+23 °C, pressure 743 mm Hg), July 5 (+29 °C, pressure 746 mm Hg), July 6 (+26 °C, pressure 741 mm Hg), during the grasses blossoming period on the reference no-nutrients site.

The soil carbon organic emission measuring was carried out on the basis of the cell static method of soil respiration intensity measuring (SRI (*ІДҐ*)) (Larionova A.A. (*Ларионова А.А.*) et al, 2001). Volume of the isolating cell - 0,1175 m^3, time of exposing - 9 minutes, depth of imbedding - 3 sm.

The results obtained. The results show distinct relation between the carbon dioxide concentration inside the isolator and exposing time with all the green manure crops as well as with the no-plants reference (Fig.1).

As the data show, the increase of carbon dioxide concentration in the cell is linear almost functionally whatever the crop. The determination coefficients vary between R^2 = 0,9909 for the lupine and R^2 = 0,9992 for the radish. With this, according to the form of the curve on the graph there is no "saturation effect". That is due to the relatively short time of exposition (9 minutes).

Differences are found in the effect of the green manure grasses upon the dynamic escaping of organic carbon (in the form of $C\text{-}CO_2$) from the sod gleyic middle-loamy soil (Fig.2).

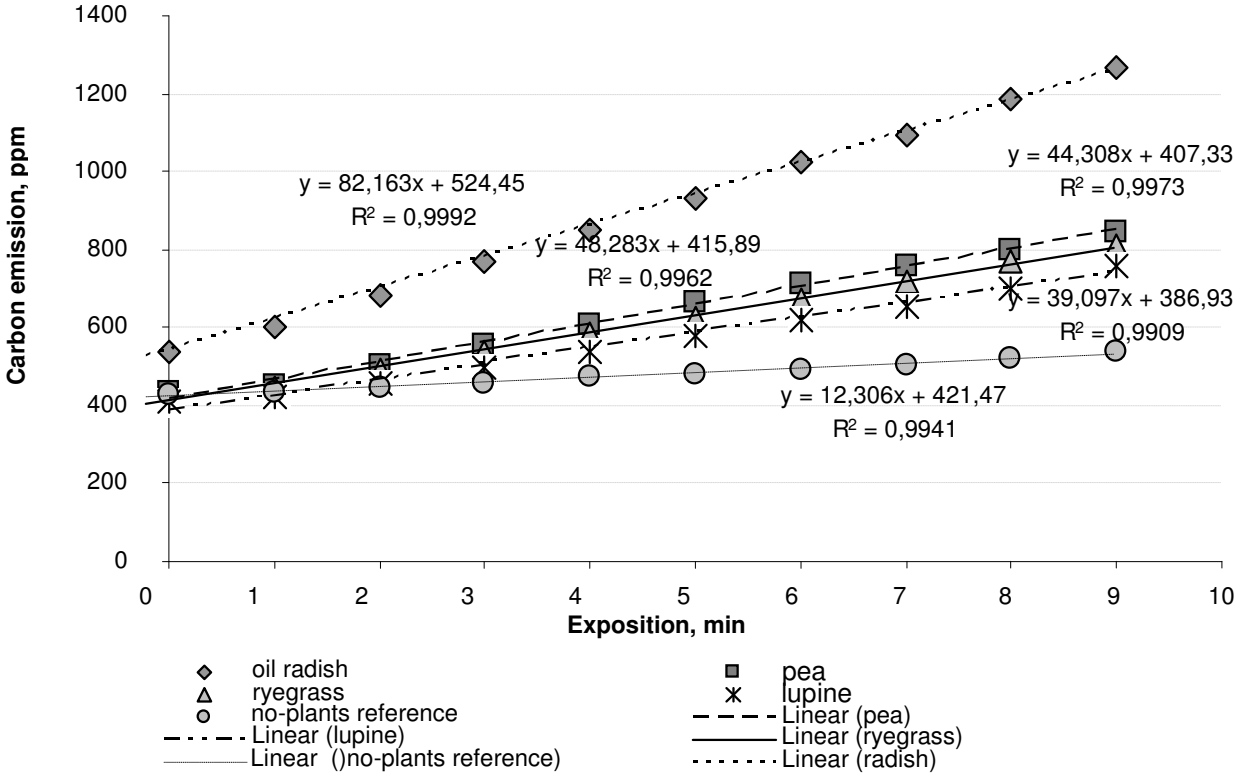
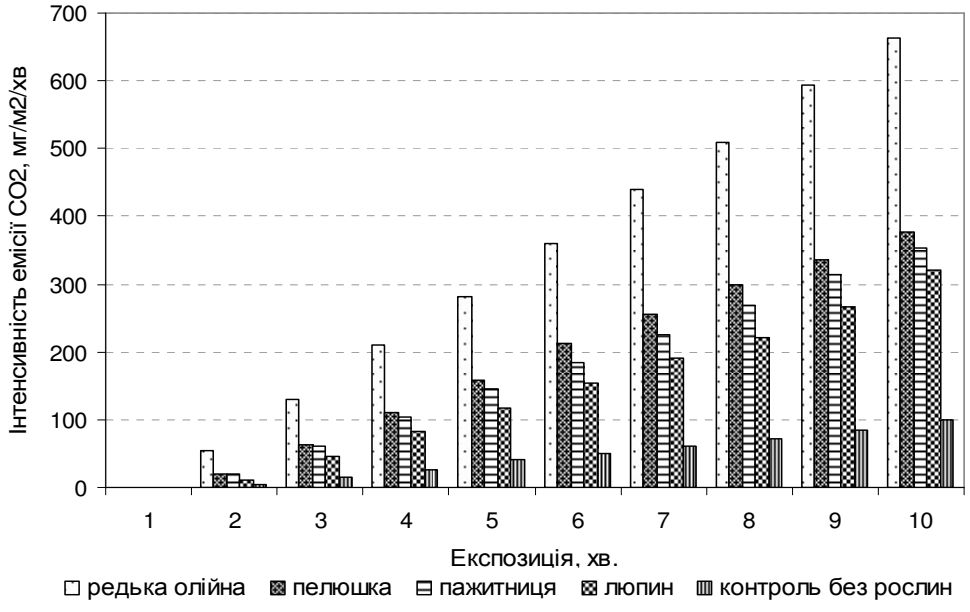


Fig.1. Change of C-CO_2 inside the isolator during the exposition time as a result of escaping from soil, ppm

Thus the range is established for green manure grasses on the sod gleyic middle-loamy soil in the order of soil respiration intensity decreasing: oil radish → Austrian winter pea → Italian ryegrass → blue lupine. With this, the rate of the carbon dioxide dissipation into atmosphere may change more then twofold with the grass variety.



(Crops: oil reddish; pea; ryegrass; lupine; no plants reference)

Fig.2. Dynamics of C-CO_2 emission from the soil (under different crops) during the exposition time, every value is average of 6 replicas (no-nutrients reference), mg/m^2/min.

Also, the ratio is informative enough of the CO_2 emission on the soil under green manure crops to that on the soil with no plants (Fig. 3). This characteristic displays to some extent the ability of the green manure crop to cause the risk of carbon accumulation in the atmosphere and consequently to increase the greenhouse effect. But the fact must be emphasized that it is the ratio of escaped carbon to carbon used by the plant for photosynthesis that must be used for assessment of the crop in the aspect of it's part in forming the soil carbon regime and regulating the atmospheric carbon flow. Besides, those carbon dioxide quantities must be accounted for which are absorbed by plants in the course of their own respiration.

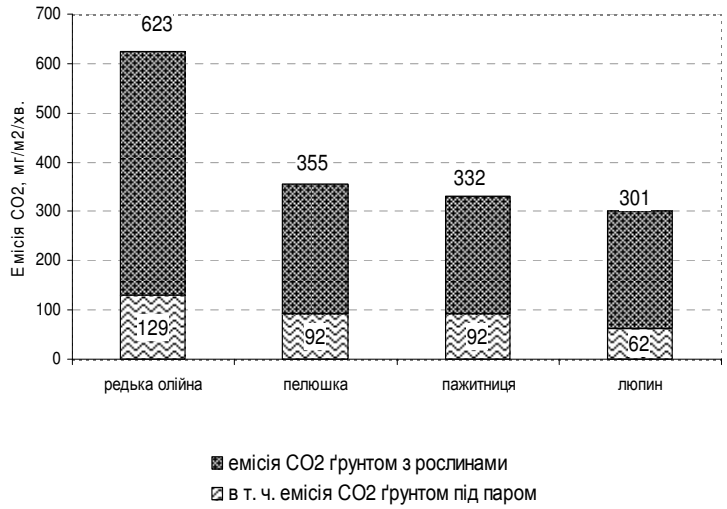


Fig. 3. Structure of carbon dioxide emission from the soil under green manure grasses and from the soil under fallow

As the data show, that part of CO_2 which emits from soil as a result of the soil respiration (under fallow) against total volume of emission from soil under the green manure crops varies from 20,6 % under lupine to 27,7 % under ryegrass (see Fig. 3). During vegetation period the highest intensity of soil respiration was observed under oil radish and the lowest one – under lupine.

As a result of the research the dependence is found of the intensity of the soil respiration upon the over-ground plants mass of the green manure crops. The correlation coefficients (r) are as follows: 0,62 for the radish (middle rate), 0,62 for the pea (middle rate), 0,46 for the ryegrass (middle rate), 0,93 for the lupine (very high rate).

That regularity indicates the over-ground plants mass as one of the determinants for the intensity of CO_2 dissipation from the soil surface. We believe that the value of the over-ground plant mass of some of the grasses might be used as an equivalent which would make it possible to find the target value of CO_2 emission in case of approximate calculation of the soil respiration intensity on the sod soils. By this, for instance, the lupine is implied for which the over-ground/root mass ratio is proportional. Here the fact must be hold in mind that it is the value of the root mass which determines the soil rhizosphere respiration intensity and CO_2 escape.

Taking into account all of the above mentioned and considering the fact that crop rotations are usually rich with energetic crops including oil radish we suggest the necessity of more calculated approach to the choice of the crop structure. The problem of insufficient knowledge on the optimal areas in crop rotation is obvious not only

concerning the green manures but other crops as well. In our view with the exceptional significance of the global worming it is necessary along with the traditional methods of the crop rotation structure planning to introduce the crops assessment in terms of their ability to increase the soil emission during vegetation period. Such approach would make it possible to minimize the risk of increasing CO_2 concentration in the atmosphere and to consider variety of crops as the efficient leverage of influencing (controlling) emission levels.

Conclusions. The linear character is found for the increase of CO_2 concentration in the isolator during the exposition period. In view of the relatively short exposition (9 minutes) the "saturation" effect was not observed.

The differences are found in the effect of the green manure grasses upon the intensity of CO_2 producing by the deep sod gleic middle-loamy soil. The range is established for green manure grasses in the order of soil respiration intensity ($mg/m^2/min$) decreasing: oil radish - 73,7 → Austrian winter pea - 42,0 → Italian ryegrass - 39,2 → blue lupine - 35,6.

The connection is proved between the soil respiration intensity and the value of the over-ground plants mass of green manure crops in the period of blooming. The correlation coefficients (r) are as follows: 0,62 for the radish (middle rate), 0,62 for the pea (middle rate), 0,46 for the ryegrass (middle rate), 0,93 for the lupine (very high rate).

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