6. Гангур В. В., Гангур М. В. Варіювання твердості грунту за різних систем його обробітку під ячмінь ярий. *Таврійський науковий вісник*. 2023. № 130. С. 29–35. DOI https://doi.org/10.32851/2226-0099.2023.130.5

7. Борзих О., Чайка В., Федоренко А., Борисенко В., Неверовська Т., Власенко І. Міняйло Н. Стан шкідливого ентомокомплексу в посівах пшениці озимої в Україні за умов зміни клімату. *Карантин і захист рослин*. 2022. № 4. С. 10–14. https://doi.org/10.36495/2312-0614.2022.4.10-14

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TOWARDS ASSESSING THE RELATIONSHIP BETWEEN THE PHYSICAL PROPERTIES OF SOILS AND THE YIELD OF AGRICULTURAL CROPS

ДО ПИТАННЯ ОЦІНЮВАННЯ ВЗАЄМОЗВ'ЯЗКІВ МІЖ ФІЗИЧНИМИ ВЛАСТИВОСТЯМИ ҐРУНТІВ І ВРОЖАЙНІСТЮ СІЛЬСЬКОГОСПОДАРСЬКИХ КУЛЬТУР

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Many factors affect the formation of the yield of agricultural crops (natural properties of the soil, methods and timing of sowing, quality of seed material, timely implementation of soil cultivation activities, application of fertilizers, meliorants and chemical plant protection agents, harvesting and post-harvest processing, etc.). However, the physical properties of the soil, which determine the water, air, temperature and nutrient regimes of the soil, play a decisive role, especially at the initial stages of plant development. The optimal physical properties of the seed layer of soils are able to provide comfortable condition for the germination of plants and the development of their root system. This leads, in the future, to the formation of a harvest of agricultural crops.

The issue of the influence of physical properties of soils on crop yield is widely covered in domestic and foreign scientific literature. In particular, the water regime of the soil and its physical properties have a direct impact on the state of soil fertility, the germination and yield of crops [1, p. 83; 2, p. 2; 3 p. 6]. Many experiments have confirmed that an increase in the optimal soil bulk density (for most crops it is 1.0–1.3 g/cm^3) by 0.1–0.3 g/cm^3 can lead to losses of 20 % to 40 % of crop yields [4, p. 21; 5, p. 53; 6, p. 143]. A significant factor in increasing the yield potential is also the soil structure, which is able to ensure optimal microbiological activity of the soil and create the best conditions for the development of the root system [7 p. 17; 8 p. 28].

However, despite the presence of numerous publications, the issue of evaluating both the combined and particular influence of each of the physical parameters of the soil on the formation of the crop yield is receiving further study. In 2020–2021, scientists at the Soil Geoecophysics Laboratory named after Academician V.V. Medvedev of the NSC ISSAR carried out research on the specified topic. The territorial object – is an agricultural field with an area of 21 hectares, located outside the settlement of the Buda, South City Territorial Community of Kharkiv District, Kharkiv Region, in the Left Bank Forest-Steppe zone of Ukraine.

For this purpose, in the field conditions we took soil samples within the object according to DSTU 4287:2004 according to a regular grid (1 point per 1 ha) using the GPS device "Garmin 9" and the main agrophysical parameters of the arable layer of the soil (0-30 cm) were determined. The structural and aggregate composition was determined by the sieve method in the modification of N.I. Savvinov (DSTU 4744:2007). The hardness of the soil was determined with a Revyakin hardness tester (DSTU 5096:2008).The soil bulk density was determined by the pedotransfer modeling method according to the developed quadratic model with the participation of indicators of the content of total humus and physical clay (the sum of fractions >0.25 mm in size) [9, p. 3]. Cultivated crops: winter wheat (2020) and sunflower (2021).

Correlation analysis was used to estimate the dependence of crop yield separately on each of the researched physical soil indicators (structural-aggregate composition, hardness and soil bulk density). The significance of the relationships between individual investigated indicators was noted, in particular, the inverse correlation between the content of the lumpy fraction (particles >10 mm in size) and the content of agronomically valuable aggregates (particles 10-0.25 mm in size) (correlation coefficient (r) was -0.99), the content of air-dry dusty fraction (size < 0.25 mm) and the content of water-stable aggregates (size > 0.25 mm) (r=-0.82), soil hardness in the layer 0-10 cm and 10-20 cm (r =-0.82) and a positive correlation between soil hardness in the 10-20 cm and 20-30 cm layers (r =0.81).

The yield of winter wheat had an average correlation with the content of agronomically valuable aggregates (r=0.59); moderate correlation – with soil hardness in the 0-10 cm layer (r=0.36). Correlation with other studied indicators turned out to be rather insignificant. Sunflower yield was characterized by similar results. It was established an average correlation between sunflower productivity and the content of agronomically valuable aggregates (r=0.52) and a moderate correlation with the content of lumpy fraction (r=0.47). The rest of the indicators were weakly correlated with crop productivity.

Linear paired mathematical models for each indicator and linear multiple mathematical models were calculated for a detailed assessment of the impact of physical indicators on the yield of cultivated crops using regression analysis. A strong correlation was recorded between the yield of winter wheat and the combined effect of the researched agrophysical indicators (r=0.84) (the coefficient of determination (R^2) was 0.71). The normalized R^2 shows how much the change in Y can be determined by the variables X, that is, this value indicates the adequacy of the regression equation. So, in our case, 51 % is the adequacy of the regression model, the standard error is at the level of 9.2 %.

Taking into account the joint influence of the studied physical parameters of the soil, a strong correlation with the yield of sunflower was found (r = 0.77; R^2 = 0.59). That is, 59 % of the variation in yield (Y) was explained by the variation in physical indicators and, accordingly, 41 % by the influence of other factors (for example, the content of humus and basic nutrients, climatic conditions, management conditions and other factors) (R^2 =0.31, the standard error was equal to 8.2 %).

In general, there was an increase in the yield of crops with a decrease in the soil bulk density, the content of lumpy fraction in the structural and aggregate composition of the soil. At the same time, with the increase in agronomically valuable fractions, crop productivity increased. Thus, the obtained results allow us to conclude that by regulating the physical

properties of soils, it is possible to significantly influence the yield of cultivated agricultural crops, i.e., optimizing the physical properties of arable soils can contribute to increasing the productivity of agricultural crops.

Bibliography:

1. Малярчук А. С., Суздаль О. С., Мишукова Л. С. Водно-фізичні властивості ґрунту під посівами ріпаку озимого за різних систем обробітку ґрунту і ранньовесняного підживлення на зрошуваних землях. *Зрошуване землеробство*: *міжвідомчий тематичний науковий збірник*. 2016. Вип. 65. С. 83–86.

2. Центило Л. В. Вплив різних систем основного обробітку ґрунту та удобрення на вологозабезпеченість посівів пшениці озимої. *Наукові доповіді Національного університету біоресурсів і природокористування України*. 2019. № 77(1). https://doi.org/10.31548/dopovidi2019.01.021

3. Sainju U. M., Liptzin D., Jabro, J. D. Relating soil physical properties to other soil properties and crop yields. *Scientifc Reports*. 2022. Vol. 12, 22025. https://doi.org/10.1038/s41598-022-26619-8

4. Карташов С. Г., Городецький Е. Ю., Дудка В. С., Москалюк А. А. Вплив оптимальної щільності ґрунту для різних сільськогосподарських культур на врожайність. *Таврійський науковий вісник. Серія «Сільськогосподарські науки».* 2012. № 78, С. 21–26. URL: https://www.tnv-agro.ksauniv.ks.ua/archives/78_2012/7.pdf

5. Медведєв В. В., Лактіонова Т. М., Линдіна Т. Є. Оцінка втрат урожаю сільськогосподарських культур в Україні від переущільнення ґрунтів. *Вісник аграрної науки.* 2002. № 3. С. 53–59.

6. Logsdon S. D., Karlen D. L. Bulk density as a soil health indicator during conversion to no-tillage. *Soil Tillage Research.* 2004. Vol. 78(2). P. 143–149.

7. Gorban V. A., Kuptsova K. S., Ostrianyn N. S., Tetiukha O. G. Structural and aggregate composition features of southern variant natural forest edaphotopes of Ukrainian steppe zone. *Ecology and Noospherology*. 2020. Vol. 31(1). P. 16–22. https://doi.org/10.15421/032003

8. Структурно-агрегатний склад ґрунту під різними сидератами у міжряддях Ginkgo biloba / Р. М. Ярощук, Е. А. Захарченко, І. М. Коваленко та ін. *Вісник Сумського національного аграрного університету: науковий журнал. Серія «Агрономія і біологія».* Суми : СНАУ, 2020. Вип. 4(42). С. 23–32. https://doi.org/10.32782/agrobio.2020.4.4

9. Спосіб визначення щільності будови ґрунту: пат. 123878 Україна: МПК G01N 33/24 (2006/01). № u 2017 09763; заявл. 09.10.2017; опубл. 12.03.2018, Бюл. № 5.