

RESEARCH ARTICLE

## The influence of care systems on biometric and yield indicators of oats

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### Abstract

Research results on study of the influence of different methods of cultivation on performance of oat on soddy-podzolic soils under the conditions of the Eastern Carpathian Foothills of Ukraine are given. Plowing to a depth of 20 cm-22 cm and 14 cm-16 cm has been established to form the highest yield of oat grains at the level of 3.5 t/ha-3.45 t/ha, which is 0.2 t/ha-0.15 t/ha more than surface tillage. Maximum protein content has appeared to be when plowing the soil to 20 cm-22 cm is 9.7%. Herewith, natural weight of oat grains decreased by 1.9%, and hull content increased by 3.6 relative percent compared to disk plowing.

**Keywords:** Yield, Productivity, Tillage, Agricultural technology, Biometric indicators, Growing season

### Introduction

Oat is one of the most common cereals in the world, the grain of which is characterized by high feed and eating qualities. Creating better conditions for its cultivation, in particular, a favorable nutritive regime of the soil, allows to ensure high plant productivity, including stabilizing grain yield (Lykhochvor et al., 2008; Hryhoriv et al., 2022).

Stabilization and increasing production of food and feeder grain are one of the primary factors contributing to development of the agricultural complex of Ukraine. Modern volumes of its production do not fully meet the needs of the national economy due to low level of yield and grain quality of major cereals. Currently the most pressing issue is production of common oat grain, the main raw material for production of high-quality cut and milled cereals, flour and fodder (Anikanova and Bakeiev, 2001; Tsyhanskyi, 2019; Hryhoriv, 2020; Tonkha et al., 2020). Taking into consideration the current environmental situation in the country, it is necessary to introduce such a cultivation technology, which would not only increase its yield, but also provide environmentally friendly grain for the production of dietary products and baby food. This technology involves refusal to use chemicals, in this regard, efficient soil cultivation plays an important role in ensuring creation of a loose lumpy structure, maximum moisture retention, clearing the field of weeds. That is why under modern conditions the main way to increase gross grain harvest, both of oats and other crops, is to improve their yields by developing new and improving existing cultivation technologies (Pykhtyn et al., 2000; Kryvobochek and Velmyseva, 2005; Pavlenko, 2007; Litvinov, 2020). Currently development of optimal agrophysical indicators of soil fertility for each crop continues to be a major challenge in agriculture. Great importance in regulating the growth and development of agrophytocenoses is given to mechanical tillage. Experiments of the scientists, in particular, Williams, Kachynsky, Rode, Doiarenko, Hedroits, Revut, Prymak showed that agrophysical properties are extremely important in soil fertility management (Zavalyn and Potapov, 1996. Bondarenko and Yakovenko, 2001; Lytvynov, 2011; Karbivska, 2020; Tabatabaei et al., 2020).

It is well known that yield is an integrated value, which is formed depending on genotype of the variety and growing conditions, among which the determining factor is regime of mineral nutrition. According to the data of research and development institutions, application of mineral fertilizers increases the oat grain yield by 0.6 t/ha -0.8 t/ha, and under specially favorable conditions by 1.2 t/ha (Kolisnyk, 2019; Rosas-Mendoza et al., 2020; Butenko, 2020). Variety is one of the major means of production, which also

plays an important role in obtaining heavy and stable yield. The newest varieties are characterized by high adaptability not only to environmental factors, but also to certain agricultural measures and are able to provide a stable level of high yields at optimum economic costs (Hapshenko and Sychevskyi, 1990; Prymak et al., 2000; Litvinov, 2019).

As of 2019, 24 varieties of common oats have been registered in Ukraine, which require development and improvement of cultivation technologies in specific soil-climatic zones, due to the fact that climatic conditions are one of the main limiting factors. Forest steppe is the traditional zone of oat growing in Ukraine (Kukresh and Bezsylyko, 1990; Karbivska, 2019; Woźniak, 2019). However, in the forest steppe zone of Ukraine influence of the methods of basic soil cultivation on growth, development and formation of oat plant productivity have not been sufficiently studied; reserves for increasing grain yield and quality depending on these agricultural methods have not been established. At the same time, due to improvement of certain elements of oat growing technology, it is possible to ensure high plant productivity and stable grain yield over the years.

## Materials and Methods

Field research was conducted on the basis of the dendrological park “Druzshba named after Zinovy Pavlyk”, Public higher education institution “Prekarpathian National University named after Vasyl Stefanyk” of Ivano-Frankivsk Oblast on soddy-podzolic surface-gleyed soil during 2017-2020.

According to the results of soil survey, the soils of experimented area are on average humic-2.63%. The amount of absorbed bases is within the range of 11 mg-12 mg-eq. per 100 g of soil, degree of saturation with bases-86%, reaction of the soil solution-acidic (pH of salt solution 4.2-4.5, hydrolytic acidity is insignificant). Field and laboratory studies were conducted in accordance with generally accepted methods of research in agronomy (Bondarenko and Yakovenko, 2001; Lytvynov, 2011).

Sowing was performed according to the experimental scheme. Arkan variety was used for sowing. Research topics involved study of the following factors: Factor A - method of basic soil cultivation:

- Plowing with PLN-5-35 plow to 20 cm-22 cm control.
- Plowing with PLN-5-35 plow to 14 cm-16 cm.
- Disking with BDT-7 heavy disc harrow to a depth of 10 cm-12 cm.

Farming culture in the experiment was generally accepted for the Eastern Carpathian Foothills of Ukraine, except for the agricultural measures studied. Sowing in the experiment was carried out with physical maturity of the soil, seeding rate was 3.5 million pcs/ha. Repeatability was four times, the area of sowing site was 240 m<sup>2</sup>, accounting site 25 m<sup>2</sup>. The predecessor is winter rape.

Mineral fertilizers at a dose of N<sub>30</sub>P<sub>60</sub>K<sub>60</sub> were applied at oats with the main soil cultivation. Although the weather conditions of growing seasons during the research years did not have an extreme effect on oat plants, they differed in variegation in certain phases of growth and development, uneven distribution of precipitation and high and increasing (compared to long-term values) temperature. The most optimal combination of hydrothermal conditions with agro-technical factors of oat cultivation was observed in 2017 and 2018. The research objective is to identify the features of forming productivity and quality of oat grain depending on the method of basic soil cultivation (moldboard plowing and disking by 10 cm-12 cm).

## Results and Discussion

Productivity of oat was studied under the contrast conditions, so their indicators varied significantly over the years. The weather conditions changed the elements of productivity in one direction or another and all this together was converted in final yield of the variety.

While studying the biometric indicators of common oat sowing with different methods of basic cultivation, it was determined that density of standing plants in the experiment ranged from 319 pcs. M<sup>-2</sup> to 329 pcs. M<sup>-2</sup>. Oat due to a well-developed root system is able to form a high density of stalk and herb, resulting in shading and reduced weeding of crops (Fig. 1).

While studying crops, vegetative stage of common oats was established- tasseling. This stage in oat lasts for 9 days-20 days, depending on soil cultivation. Temperature rise in a long daylight reduces it. In tasseling stage oat plant was 79 cm-94 cm high at different variants of the examined area.

Analysis of the dynamics of forming biometric indicators of plants shows that the number of productive stems and plant height were greater than growing oats on the background of plowing to 20 cm-22 cm. Oat plants by this technology were better developed and were on average 94 cm high. In such crops there is also a trend to reduce weeds, also in this case, a larger number of productive stems was formed, making 329 pcs. m<sup>-2</sup>. When cultivating 10 cm-12 cm, height of the plants was within 79 cm, there was a decrease in number of stems of oat plants by 10 pcs. m<sup>-2</sup>-15 pcs. m<sup>-2</sup>.

It has established that the highest grain size of panicle is 28.5 psc. was registered at the control of plowing to 20 cm-22 cm, and when reducing depth of plowing and surface tillage, this figure decreased by 2.5%-3%.

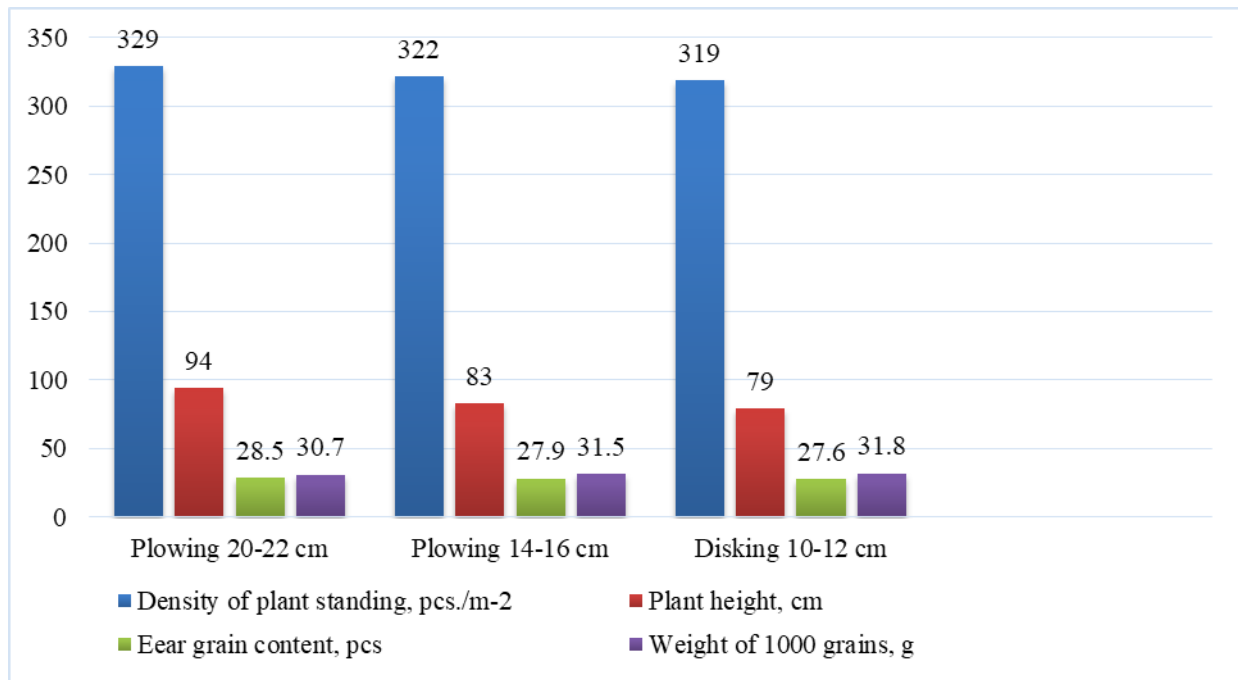


Figure 1. Biometrical indicators of common oat sowing by different methods of basic cultivation (mean value for 2017-2020)

Regarding the weight of 1000 grains, it was determined that the best indicators were for surface tillage to 10 cm-12 cm, and was 31.8 g, and for the main tillage this indicator decreased by 3.9%.

Depth of penetration of the root system into the soil is important for obtaining stable yields of field crops. Depth of root penetration into the soil depends not only on moisture conditions, but also on the mechanical and chemical composition of arable and subsoil layers of the soil (Tab. 1).

Table 1. Influence of cultivation methods on oat development.

Depth of cultivation, cm	Green matter of plant, g	Weight of the root system, g	Ratio of root weight to green matter
Plowing to 20-22 cm (control)	520	80	01:06.5
Plowing to 14-16 cm	380	50	01:07.6
Surface tillage to 10-12 cm	340	37	01:09.1

Also, one of the main conditions for enhanced initial root growth consists in sufficient moisture in the arable soil layer. Insufficient soil moisture has a negative effect on growth of the root system and top, which was observed in 2017 study. Along with changes in biometric indicators of growth and development of oat plants, different intensity of forming crop structure elements was observed. Thus, cultivation to 20 cm-22 cm helped to increase green matter of oat plants. Under such conditions, higher yields of oats were formed in the studied technologies.

At cultivations to 10 cm-12 cm and 14 cm-16 cm, the level of oat performance tended downward. The main factor in the objective assessment of different methods, measures, depths and systems of mechanical soil cultivation is the level of yield and agricultural crop capacity in general. Yield as an indicator of the performance of phytocenosis a derivative of the factors and conditions in which it is formed. Therefore, fluctuations of each factor are sure to affect final yield of this crop.

Common oat yield with different methods of basic soil cultivation was almost the same 33.0 quintals-35.0 quintals of seeds per hectare, which is optimal for this variety. There was no significant difference in the yield of by-products (straw) using the methods of basic tillage (Tab. 2).

Table 2. Common oat yield with different methods of basic soil cultivation

Variant	Seed harvest, t/ha	By-product (straw) yield, t/ha
Plowing to 20-22 cm (control)	3.5	5.3
Plowing to 14-16 cm	3.45	5.2
Surface tillage to 10-12 cm	3.3	5.23

HIPo5 (2017): A-0.147; B-0.147; AB-0.210.

HIPo5 (2018): A-0.173; B-0.173; AB-0.239.

HIPo5 (2019): A-0.076; B-0.076; AB-0.106.

HIPo5 (2020): A-0.175; B-0.175; AB-0.225.

On average over the years of plowing to 20 cm-22 cm (control) oat grain yield was formed at the level of 3.5 t/ha, while increase

in yield compared to plowing to 14 cm-16 cm and disking to 10 cm-12 cm was 0.05 t/ha-0.2 t/ha. It should be noted that the same trend was observed in by-product yield.

Thus, use of surface tillage as the main one does not affect common oat yield compared to plowing to 20 cm-22 cm, but at the same time is more cost-effective when growing crops. Analyzing the yield indicators, it is necessary to pay attention to participation of the studied factors in forming performance of oat crops. According to our data, the methods of basic soil cultivation had a slightly stronger effect than the variety characteristics. Thus, on average over the years of research, share of the method of soil cultivation was 56%, of varieties-42%, of interaction of factors-2%.

Our research has shown that agronomical practices influenced also the quality of oat grain. Thus, on average in 2017-2020, when plowing to 20 cm-22 cm, protein content in oat grain was 9.84%, and when disking to 10 cm-12 cm, it decreased by 0.4 absolute percent and amounted to 9.44% (Fig. 2). Conditional protein yield per area unit is an important criterion for efficiency assessment of this or that agronomical practice as it characterizes the yield and protein content of grain. On average, over the years of research, this figure was almost the same when plowing and disking 9.7% and 9.3%, respectively. The maximum conditional protein collection was recorded when growing oats with plowing to a depth of 20 cm-22 cm of soil.

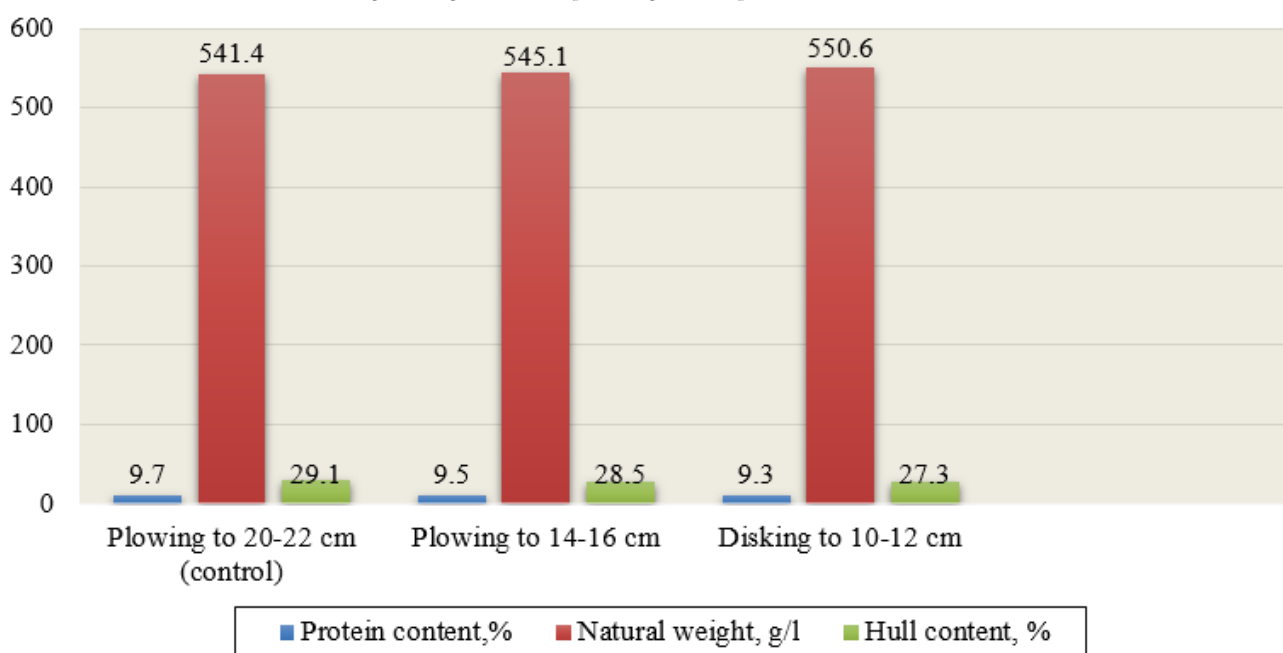


Figure 2. Influence of the method of basic soil cultivation on oat grain quality indices (mean value for 2017-2020)

The method of basic soil cultivation also influenced other technological indicators. Thus, the largest natural weight was characterized by grain grown on the background of disking-550.6 g/l, hull content was 27.3%. When plowing, natural weight of oat grain decreased by 1.5%-2.8%, and hull content increased by 0.9%-1.0% depending on the method of cultivation.

## Conclusions

Plowing to a depth of 20 cm-22 cm as the main cultivation on average over the years increases productive stem standing of oats by 4.9%. Whereas in surface tillage the panicles of plants are less grained (by 4.6%), but the grain is larger (weight of 1000 grains is 31.8 g, which is 4% more than when plowing). After plowing, the yield of oat grain is formed at the level of 3.5 t/ha-3.45 t/ha, depending on the method of cultivation, while increase in yield compared to disking is 0.2 t/ha-0.15 t/ha. The maximum protein content with plowing the soil to a depth of 20 cm-22 cm was 9.7%. Herewith, natural weight of oat grains decreased by 1.9%, and hull content increased by 3.6 relative percent compared to disking.

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