Spring Oats - A Crop Dependent on Climate and Technological Conditions

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Abstract. *The study analyzed the productivity and quality of the spring oat variety Ovidiu. The variety was cultivated within ARDS Lovrin, under non-irrigated cultivation conditions. Two experimental factors were analyzed – crop fertilization (with two graduations) and soil cultivation (with four graduations). Production was determined quantitatively at crop harvest. Regarding the main productivity elements: panicle length, number of grains/panicle, grain weight/panicle, straw length, TKW, HLW – these were obtained by analyzing a number of 50 plants for each experimental variant. The protein percentage was determined in the laboratory using the Kjeldahl method. Among the four types of soil cultivation practiced for the establishment of the spring oat crop, for the western area of Romania the most efficient is the method of preparing the germinal bed with the heavy disc. By using this method, the costs of land preparation are reduced by 73%. The economic efficiency of disc tillage also derives from the higher yields per hectare obtained compared to the other three methods, the quality of the productions, and better storage and preservation of water in the soil.*

Keywords*: spring oats, plowing, scarifying, disc work, fertilization.*

INTRODUCTION

The exploitation of agricultural land through incomplete or incorrect strategies seriously affects both the quantity and quality not only of agricultural production but especially of soil resources.

Crop development depends on the growth and development of plant roots in loose soil with good water retention capacity and nutrient absorption. In this regard, optimal soil tillage is required, while the use of plowing methods generally leads to soil compaction (Gürsoy, 2021; Mileusnić et al., 2022). Climate change, manifested through atmospheric drought, decreased precipitation, and uneven distribution throughout the agricultural year, requires urgent measures for conserving and retaining water in the soil (Chețan, 2021; Rusu et al., 2011).

The use of alternative soil tillage methods, with minimal disturbance, is an alternative to conventional tillage; however, these methods must be thoroughly studied, considering that soil tillage is dependent on the soil type (Dinuta, 2024). Through the use of minimum tillage methods, a large portion of plant residues is incorporated or maintained on the surface, functioning as a natural mulch (Chețan et al., 2021; Copcea et al., 2018; Derpsch, 2001). High yields of spring crops, which increasingly dominate crop structures, can be ensured through appropriate fertilization and agronomic practices adapted to each crop (Bărdaș et al., 2022; Ceclan et al., 2022; Chiriță et al., 2024; Șimon et al., 2022).

Oats are ranked sixth in terms of cultivation area and productivity, after wheat, corn, rice, barley, and sorghum. The presence of adapted varieties and favorable climatic conditions allows for successful cultivation in countries such as the United Kingdom, Germany, Sweden, Finland, and France (Hoffman, 1995). It is a crop well adapted to difficult climatic conditions—low temperatures and low precipitation. To achieve high yields, optimized technology is necessary, including the appropriate sowing period (Zhang et al., 2019).

Global studies show that drought and atmospheric heat are the main causes of low cereal yields (IPCC, 2014). Abiotic stress drastically reduces cereal productivity, affecting plant growth and development, biomass accumulation, and may even cause plant death (Witcombe et al., 2008; Deryng et al., 2014; Niu et al., 2014). Climate predictions are not particularly encouraging—average temperatures continue to rise, and extreme weather events are becoming more frequent (Battisti & Naylor, 2009; Diez et al., 2012).

Given the increasingly evident climate changes, it becomes necessary to study and understand crop responses to extreme conditions. Stress tolerance is the plant's ability to grow and produce yields despite the presence of abiotic stress (Mickelbart et al., 2015).Acclimatization is one of the most important processes that cereal crops must undergo (Thomashow, 2010). The duration of this process varies from a few hours—for thermal stress (Senthil-Kumar et al., 2003; Rampino et al., 2009)—to several days for frost stress (Byun et al., 2014). During the acclimatization process, the expression level of many stress-responsive genes is altered (Hua, 2009; Jia et al., 2016).

Cereal crops, having a relatively underdeveloped root system, can be cultivated under various soil tillage conditions. This project analyzed four types of soil work (plowing, heavy disc, deep scarification, shallow scarification) for the spring oat crop, aiming to identify the optimal variant for the western region of the country, one that ensures high-quality yields with minimal disturbance to soil structure.

MATERIAL AND METHODS

The experiment was established at ARDS Lovrin on a typical, weakly gleyed, medium clay loam chernozem.

The spring oat crop, variety *Ovidiu*, was studied in relation to the type of soil tillage and fertilization system, with the following grading of experimental factors:

Factor A – type of soil tillage:

- a1 – soil tillage using a heavy disc
- a2 – soil tillage through shallow scarification (20 cm)
- a3 – soil tillage through deep scarification (50 cm)
- a4 – soil tillage through plowing (18 cm)

Factor B – crop fertilization:

- b1 – NPK 15:15:15 – 150 kg of commercial product
- b2 – NPK 15:15:15 – 150 kg of commercial product + 200 kg of commercial ammonium nitrate (33.5%).

An analysis of the precipitation regime data shows that the 2023–2024 agricultural year was an atypical one overall (Figure 1), with recorded rainfall values significantly below the multiannual monthly average in most months of the year. The uneven distribution of rainfall—by decade, month, and year—had a negative impact on crop development. The total amount of rainfall during the 2023–2024 agricultural year was 417.4 mm, which represents a negative deviation of 104 mm compared to the multiannual average. During the vegetation period of the spring oat crop (March–July), the total rainfall was 131.6 mm, with a negative deviation of 124.6 mm from the multiannual average. During this period, out of 153 days, there were 123 days with no rainfall at all, 12 days with daily rainfall between 0–1 mm, 26 days with daily rainfall between 1–10 mm, and only 2 days with daily rainfall exceeding 10 mm.

This rainfall deficit, combined with excessive temperatures and atmospheric drought, intensified the phenomenon of both soil and atmospheric drought, drastically reducing yields per unit area.

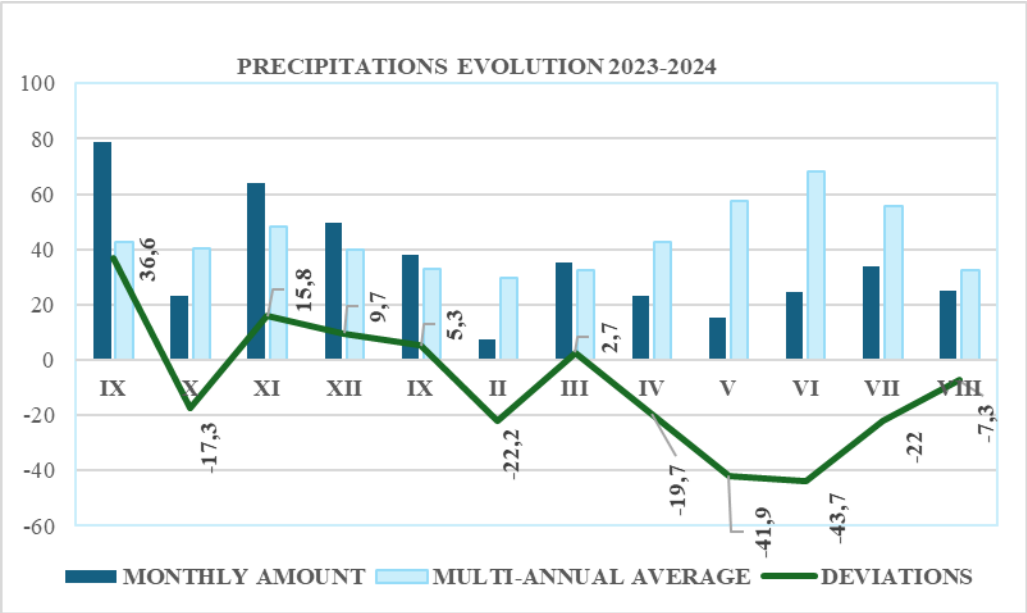

Figure 1. Precipitations evolution at ARDS Lovrin, 2023–2024

The average annual temperature was 14.6°C, which was 3.6°C higher than the multiannual average over 70 years (10.9°C) (Figure 2). During the crop growing season, monthly temperatures exceeded the multiannual average. The associated atmospheric heat, along with the lack of precipitation, negatively affected the progression of phenophases and, consequently, the yield obtained. The largest deviations from the average were recorded from February to July. Thus, in February, a positive deviation of +7.0°C was recorded, in March +4.3°C, in April +3.1°C, in June +3.8°C, and in July +4.6°C.

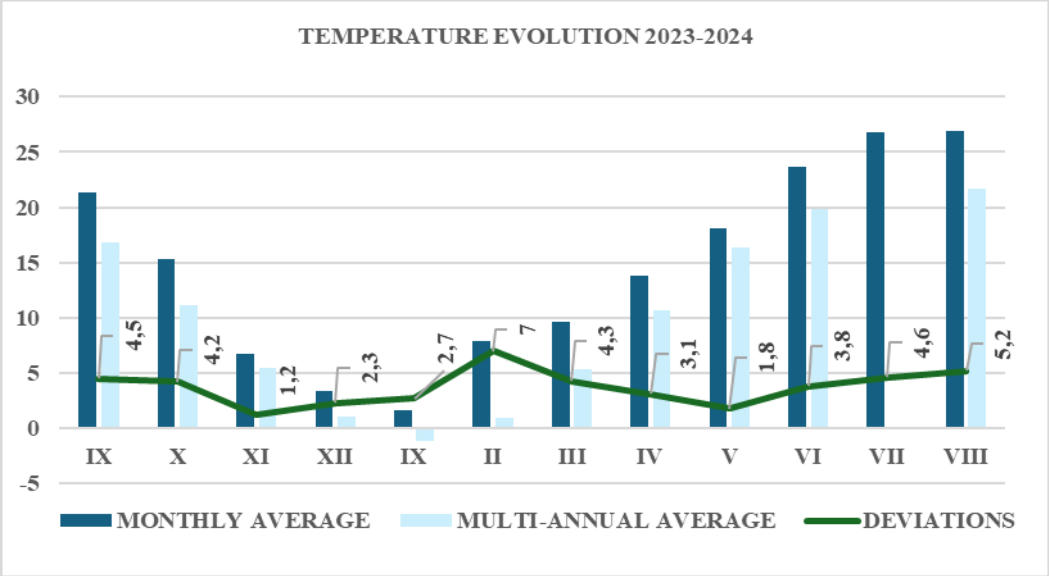

Figure 2. Temperature evolution at ARDS Lovrin, 2023-2024

RESULTS AND DISCUSSIONS

The results obtained under the conditions of the 2023-2024 agricultural year are analyzed and presented below. The production, the main elements of productivity and the quality of the crop were analyzed, under the various conditions imposed by the experimental factors.

In Table 1 are presented the production results.

Table 1. Table of comparisons for production (interaction soil work x fertilization)

Experimental factors		Production	Difference	%	Significant
NPK	**Disc harrowing**	3413,5	100,0	0,00	Control
	Light scarification	3339,0	97,8	-74,50	-
	Deep scarification	3172,0	92,9	-241,00	-
	Plowing	3227,0	94,5	-186,00	-
NPK + NH_4NO_3	**Disc harrowing**	3834,0	100,0	0,00	Control
	Light scarification	3658,0	95,4	-176,00	-
	Deep scarification	3446,0	89,8	-388,00	-
	Plowing	3593,0	93,7	-241,00	-
LSD 5% - 367,35; LSD 1% - 637,98; LSD 0,1% - 1298,81.					

Analyzing the table of comparisons for the production obtained per unit area, it is also noted in the classical fertilization system and in the supplementary fertilization system the variant of soil preparation with the disk. Thus, in the classical fertilization system (NPK) the difference in production compared to the control (soil preparation with the hard disc) for the other three types of soil preparation is negative and varies between - 74.5 kg and - 241 kg/ha, and in the supplementary fertilization system the difference compared to the control reaches a negative maximum of -388 kg/ha. In both cases, the lowest production was obtained when preparation the soil by deep scarification and the best results when preparation the soil with the disc.

Regarding the main productivity elements: panicle length, number of grains/panicle, grain weight/panicle, straw length, thousand kernel weight (TKW), hectoliter weight (HLW) – these were obtained by analyzing a number of 50 plants for each experimental variant and are presented in the following figures.

The panicle length varies between 17.72 cm – 20.98 cm in the case of basic fertilization, respectively 18.42 cm – 22.78 cm in the case of nitrogen-supplemented fertilization.

The number of grains/panicle is higher in the variants worked by deep scarification and plowing, compared to those worked with the disk or by superficial scarification. The weight of grains/panicle, however, is higher in the case of the first two types of soil cultivation.

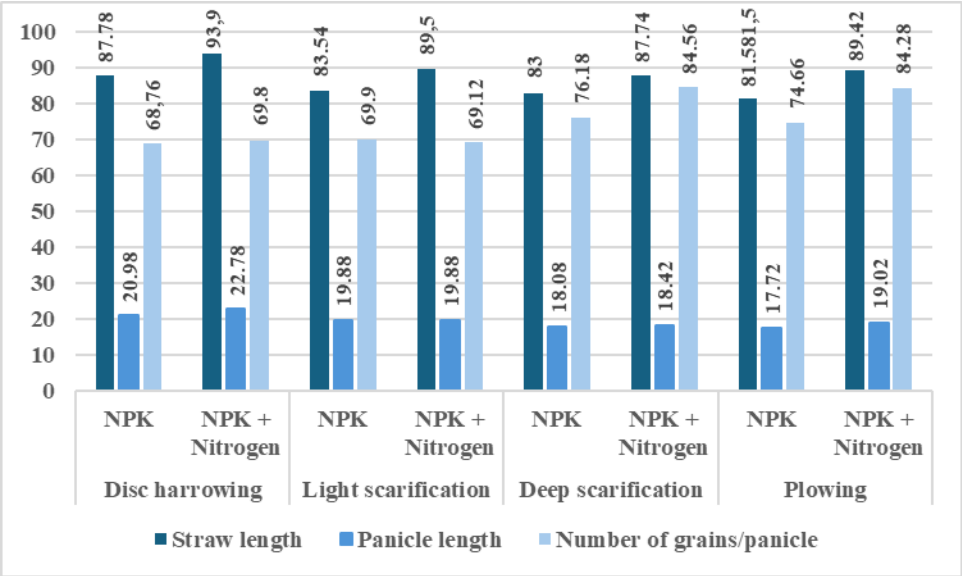

Figure 3. Evolution of productivity elements – straw lenght, panicle lenght, number of branches/ panicle

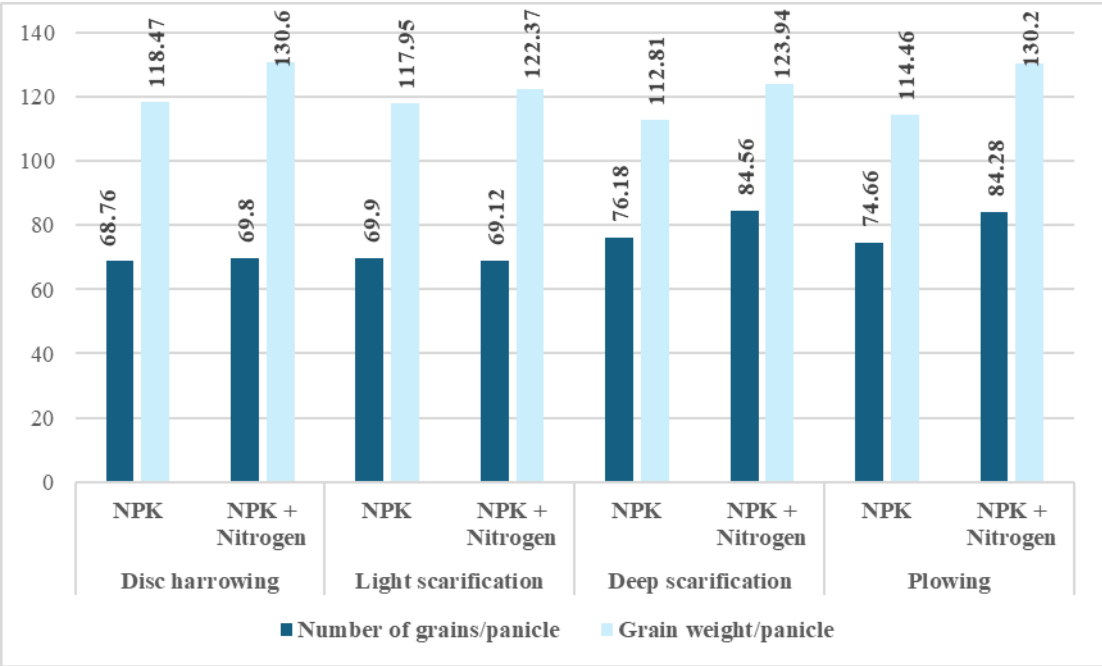

Figure 4. Evolution of productivity elements – number of grains/ panicle, grain weight/ panicle

And the hectoliter mass varies depending on the type of fertilization and the type of soil cultivation (Figure 5).

The thousand kernel weight when applying basic fertilization varies between 28.82 g – 29.98 g, with the highest value recorded in the plowing variant, closely followed by the other variants. When applying supplemented fertilization, TKW varies from 28.81 g to 29.21 g, with the highest value in the discing variant.

The hectoliter weight also varies depending on the type of fertilization and the type of soil cultivation (Figure 5).

In this case, the work of cultivating the soil with the disk is also noticeable, followed by the work of superficial scarification.

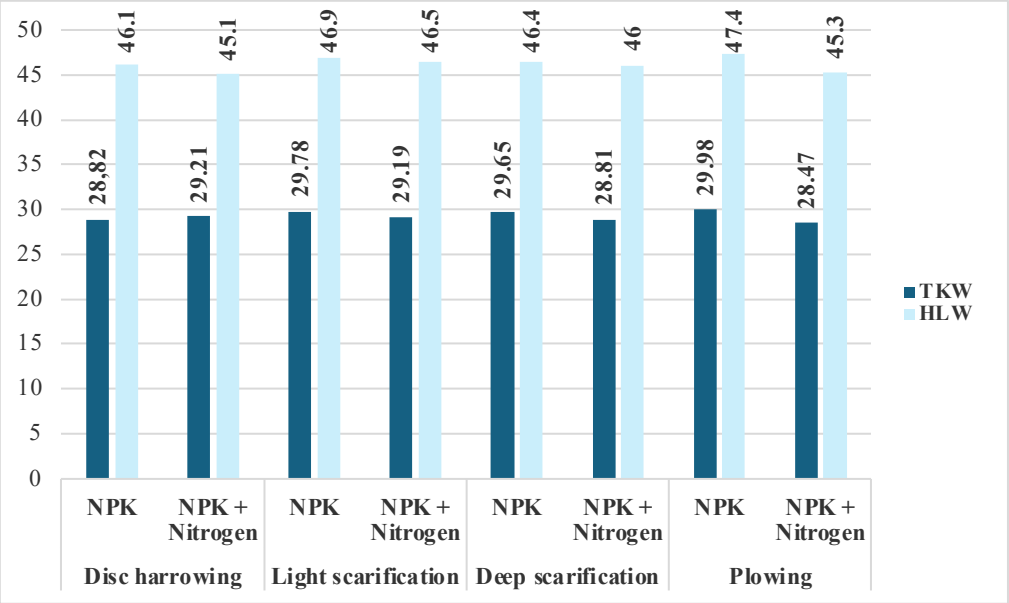

Figure 5. Evolution of productivity elements – TKW, HLW

Regarding the quality of the crop, the protein percentage was determined. The analysis was carried out in the quality laboratory of SCDA Lovrin, using the Kjeldahl method. The results obtained are presented in Table 2. The analysis of the presented data indicates a variation in the protein content in the range of 12.05% - 12.8% when applying basic fertilization and in the range of 13.35% - 14.05% when applying additional nitrogen fertilization.

Table 2. Comparison table for protein content - influence of fertilization and type of tillage

Experimental factors		Protein (%)	Difference	%	Significant
NPK	**Disc harrowing**	12.80	100.0	0.00	Control
	Light scarification	12.40	96.90	-0.40	-
	Deep scarification	12.40	96.90	-0.40	-
	Plowing	12.05	94.10	-0.75	00
NPK + NH_4NO_3	**Disc harrowing**	14.05	100.0	0.00	Control
	Light scarification	13.60	96.80	-0.45	0
	Deep scarification	13.35	95.00	-0.70	00
	Plowing	13.40	95.40	-0.65	00
LSD 5% - 0.44; LSD 1% - 0.62; LSD 0,1% - 0.88.					

The influence of additional nitrogen fertilization, as shown by the variance analysis (Table 3), is distinctly positive for the 1% transgression probability.

Table 3. Comparison table for protein content - influence of fertilization

Fertilization	Protein (%)	Difference	%	Significant
NPK	12.41	100.0	0.00	Control
NPK + NH_4NO_3	13.60	109.6	1.19	**
LSD 5% - 0.45; LSD 1% - 1.05;109.6 LSD 0,1% - 3.33.				

The type of tillage also has a significant influence on the quality of the spring oat crop (Table 4). Thus, compared to the minimal tillage with a heavy disc (control), the other three types of tillage significantly, distinctly significantly and very significantly influence this quality index analyzed.

Table 4. Comparison table for protein content - influence of type of tillage

Fertilization	Difference	%	Significant	Difference
Disc harrowing	13.43	100.0	0.00	Control
Light scarification	13.00	96.80	-0.43	0
Deep scarification	12.88	95.90	-0.55	00
Plowing	12.73	94.80	-0.70	000
LSD 5% - 0.31; LSD 1% - 0.44;109.6 LSD 0,1% - 0.62.				

It is noted as in the case of production and productivity elements - the work of preparing the soil with the heavy disc.

CONCLUSIONS

Of the four types of soil tillage practiced for the establishment of spring straw cereal crops, for the western area of Romania the most efficient is the method of preparing the seedbed with the heavy disc. By using this method, the costs of land preparation are reduced by 73%. The highest production was recorded in the variant of soil cultivation with a heavy disk, both with basic fertilization and with the application of additional nitrogen fertilization, the production increase compared to the classic soil preparation work with a plow being 241 kg/ha. The formation of productivity elements and the quality of the crop is positively influenced by this type of soil cultivation.

The economic efficiency of soil tillage with the disc also derives from the higher yields per hectare obtained compared to the other three methods, the quality of the productions and a better storage and preservation of water in the soil.

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