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THE INFLUENCE OF TILLAGE SYSTEMS ON THE OCCURRENCE OF DISEASES AND PESTS ON SPRING CEREALS, IN THE TRANSYLVANIAN PLATEAU

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Abstract. In recent years, spring straw crops have expanded due to the increasing variability of autumn weather, which affects germination and emergence, while spring generally provides sufficient moisture for proper cereal development. Another advantage of these crops is their productivity, often comparable to or even higher than that of autumn crops. Research carried out at the Agricultural Research and Development Station Turda, between 2023 and 2025, examined the influence of four soil tillage systems (plowing, minimum tillage with chisel, minimum tillage with disc, and no-tillage) on the occurrence of diseases and pests in three spring cereal species (wheat, oat, barley), within a split-plot experiment with two replications. Basic fertilization (300 kg/ha NPK 15:15:15) was applied at sowing. Phytosanitary assessments conducted at stem elongation and flowering aimed to identify the main diseases and to estimate the frequency and intensity of attacks. Pest monitoring was performed through 100 double sweep-net samples every 10 days, from the booting stage until two weeks before harvest. Chemical treatments and plowing systems significantly reduced disease and pest pressure; however, a higher number of harmful organisms was recorded in the no-tillage system due to the presence of plant residues that favor their development cycle.

Key words: *tillage system, disease, pest, spring cereals*

INTRODUCTION

Spring cereals are valuable crops due to their drought tolerance and short growing season, making them suitable for compensating failed autumn crops or for cultivation in regions with brief springs (Chmielewski & Köhn, 1999). They are used for flour production, animal feed, and particularly in the case of barley for malting (Sułek & Cacak-Pietrzak, 2018; Duda et al., 2021; Sinkevičienė et al., 2025). Their profitability can be significantly improved through modern technological management, including high performance varieties and appropriate treatments (Chețan et al., 2024; Rusu et al., 2024).

In the hilly Transylvanian Plateau, inadequate agricultural technologies, insufficient production means, and poor erosion control have resulted in low yields in recent years. The region's climatic conditions require spring cereal varieties adapted to short, cold springs and cool summers, with resistance to foliar diseases and drought, as well as the ability to mature before summer drought. Direct seeding supports soil conservation by preserving structure, maintaining moisture, and reducing compaction. As such, conservation agriculture offers a

sustainable approach that protects natural resources and lowers long-term production costs (Rusu et al., 2024).

Tillage is employed to mechanically aerate the soil, promoting root development and overall plant growth (Khan, 2008). In rainfed and dryland systems, its primary objectives include creating favorable conditions for seed germination and root penetration, suppressing weeds, minimizing soil erosion (Chalise et al., 2020), conserving moisture, and reducing runoff (Unger & Cassel, 1991; Miron & Stroe, 2024; Chețan & Chețan, 2021). Commonly implemented techniques in these environments include minimum or optimal tillage, reduced tillage, conservation tillage, mulch tillage and no-till (www.rica.rw). Minimum and reduced tillage systems contribute to lower energy and labor requirements (Dvoskin & Heady, 1977), improved seed placement (Blunk et al., 2021), reduced soil compaction, and enhanced moisture retention while mitigating erosion. Conservation tillage maintains continuous soil cover through crop residues, thereby limiting runoff, evaporation, and soil temperature fluctuations. No-till practices, which involve direct seeding without prior soil preparation (Chețan, 2020), further conserve energy and moisture and allow earlier planting after rainfall, although they may increase weed pressure at later growth stages (Porazinska & Wall, 2013; Gawęda et al., 2020). The presence or absence of tillage also influences the dynamics of pests (Jasrotia et al., 2023) and diseases, including *Fusarium pseudograminearum, Septoria nodorum, Pyrenophora tritici* and *Mycosphaerella pinoides* (Wozniak & Soroka, 2015; Flower et al., 2019).

Research indicates that in soybean, the combined application of ploughing, balanced fertilization, and fungicide treatments, with or without insecticides, is most effective in reducing disease (*Peronospora manshurica, Pseudomonas savastanoi* pv. *glycine*) and pest attacks including *Tetranychus urticae, Autographa gamma, Agrotis segetumand* and *Mamestra oleracea* (Suciu et al., 2021; Tărău et al., 2020). Furthermore, unconventional soil management systems that retain high amounts of plant residues can favor certain pests, such as *Ostrinia nubilalis*, whereas species like *Delia platura* may be more abundant in intensively tilled soils (Rowen et al., 2020).

The purpose of the research carried out at the Agricultural Research and Development Station Turda was to evaluate the influence of soil tillage systems (conventional, minimum tillage with chisel, minimum tillage with disc and no-tillage) on the occurrence of diseases, pests and entomophagous in three spring cereal species (wheat, oat and barley) cultivated on the Transylvanian Plateau.

MATERIALS AND METHODS

The experimental field with conservation tillage systems was established in the autumn of 2023. The technological components were evaluated comparatively within four systems and three spring cereal crops. The experiment was set on a Phaeozem-type soil (SRTS, 2012) with a medium humus content. The established crop rotation had a three-year cycle and included: soybean - spring cereals - maize.

Experimental factors:

- Factor A, soil tillage system (four graduation): a_1, conventional tillage (CT): plowing in autumn + seedbed preparation in spring using a rotary harrow + sowing + fertilization; a_2, minimum tillage (MTC): chisel plow in autumn + seedbed preparation in spring using a rotary harrow + sowing + fertilization; a_3, minimum tillage (MTD): disc harrow in autumn +

seedbed preparation in spring using a rotary harrow + sowing + fertilization; a_4, no-tillage (NT): direct sowing into the previous crop stubble + fertilization.

- Factor B, species (four graduation): b_1, spring wheat: Feleacu variety; b_2, spring oat: Mureșana variety; b_3, spring oat: Vâlcele variety; b_4, spring barley: Romanița variety.

- Factor C, year (climatic conditions): c_1 2024; c_2 2025.

The sowing of wheat and oat was carried out in the third decade of February, and barley in the first decade of March, with the Diretta machine, at a density of 500 germinated grain/m^2 and a row spacing of 18 cm. Fertilization was done with 300 kg/ha NPK 15:15:15 simultaneously with sowing. Foliar fertilizers were applied together with chemical treatments (Table 1).

Table 1. Chemical treatments

Treatment 1	Treatment 2
0,6 L/ha Falcon Pro (protioconazole 53 g/L + spiroxamine 224 g/L + tebuconazole 148 g/L) + 0,2 L/ha Leptostar SL 200 (200 g/L acetamiprid) + 1,0 kg/ha Tonivit (phosphorus 13%, potassium 5% and GA 142- seaweed extract *Ascophyllum nodosum*)	1,0 L/ha Revicare (mefentrifluconazole 100 g/L + piraclostrobin 100 g/L) + 0,25 L/ha Mavrik 2F (Tau-fluvalinate 240 g/l) + 1,0 kg/ha Lithovit Forte (75% $CaCO_3$ + 5% MgCO + 42,2% alkaline constituents)

Phytosanitary assessments were carried out on spring cereal crops at two phenological stages, stem elongation and flowering. Foliar diseases were assessed by analyzing 100 plants for each experimental treatment, determining both incidence and severity according to the European and Mediterranean Plant Protection Organization (EPPO) standards, and using the Saari and Prescott scale for severity estimation (Saari & Prescott, 1975). Monitoring of pests in the experimental crops was carried out by collecting specimens using a standard entomological sweep net with a diameter of 30 cm and a 50 cm handle. For each sample, 100 double sweeps were performed at 10-day intervals, starting from the late tillering stage and continuing until two weeks before harvest, exclusively on days without precipitation or wind. After collection, the samples were stored in cold conditions, and subsequently, the pest species present in the four soil tillage systems in wheat, oat, and barley crops were identified. Based on species identification and the recorded number of pests per sweep, the average pest abundance was calculated for each cultivated species within each soil tillage system.

The results were statistically analyzed using ANOVA (2015), with the least significant differences calculated at the 5, 1 and 0.1% levels using the Microsoft Excel program. Climate conditions at ARDS Turda from the 2023/2024-2024/2025 agricultural years (October-July) are used (source: Turda Meteorological Station, 23°47E/46°35'N/427 m OSL).

RESULTS AND DISCUSSIONS

Climatic records from the last 67 years at Turda indicated a multiannual mean temperature of 9.3°C and an average annual precipitation of 532.4 mm (Figure 1).

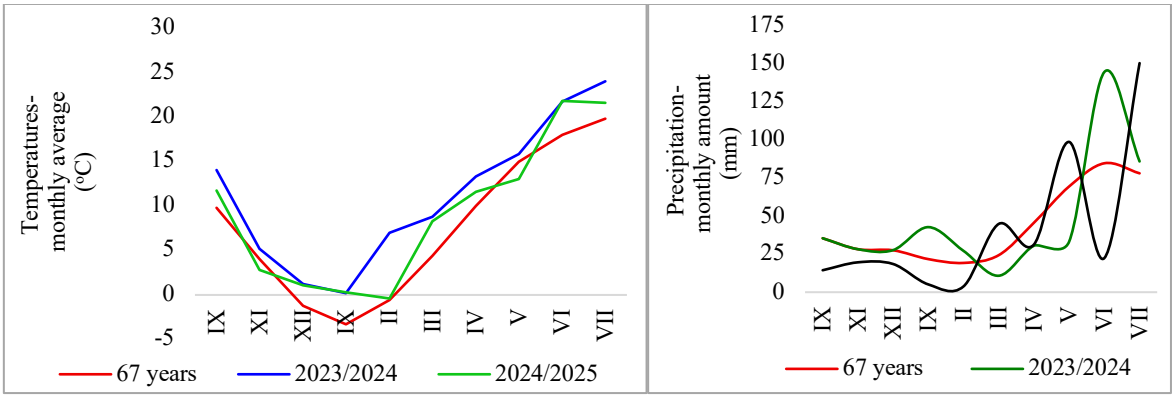

Figure 1. The weather conditions in Turda, 2023/2024-2024/2025

The thermal regime clearly indicated an upward trend in annual temperature values. The precipitation regime was characterized by an uneven distribution; under these conditions, the importance of soil water conservation increased. The uneven precipitation combined with high temperatures and prolonged drought influenced the occurrence of harmful agents, the phytosanitary condition of the cultivated plants, and, consequently, the yield and its quality indicators.

The phytosanitary assessments carried out in the third decade of May and the second decade of June indicated the absence or negligible presence of foliar pathogens during the first evaluation, which coincided with the stem elongation stage. No symptoms were observed in wheat, barley and oat at this time; however, herbicide-related phytotoxicity was recorded in oat. In the first oat cultivar, phytotoxic symptoms appeared in 90% of plants, with an estimated intensity of 50%, affecting two leaves per plant, whereas the second cultivar exhibited milder reactions, with 75% of plants affected and an intensity of 25%, also on two leaves. No fungal pathogens were detected at this early stage.

During the second phytosanitary assessment, foliar diseases were recorded at very low levels across all species and tillage systems. In wheat, *Zymoseptoria tritici* was detected with an incidence of 1% in all treatments, while severity values ranged between 5% (CT) and 25% (NT), indicating slightly higher disease pressure in the reduced-tillage systems (Figure 2).

In oat, *Pyrenophora avenae* occurred sporadically in both cultivars, with a constant incidence of 1% and severity values ranging from 1% to 5%, confirming its low epidemic potential during the study year. In barley, *Helminthosporium teres* displayed a wider severity range, from 1% in CT to 25% in NT, although incidence remained low (1%) across all systems. Additionally, *Ustilago nuda* was identified in barley at an incidence of 1%, without notable disease progression. Overall, the very low severity recorded at the second evaluation suggests that seed treatment and timely fungicide applications were highly effective in restricting pathogen establishment and spread.

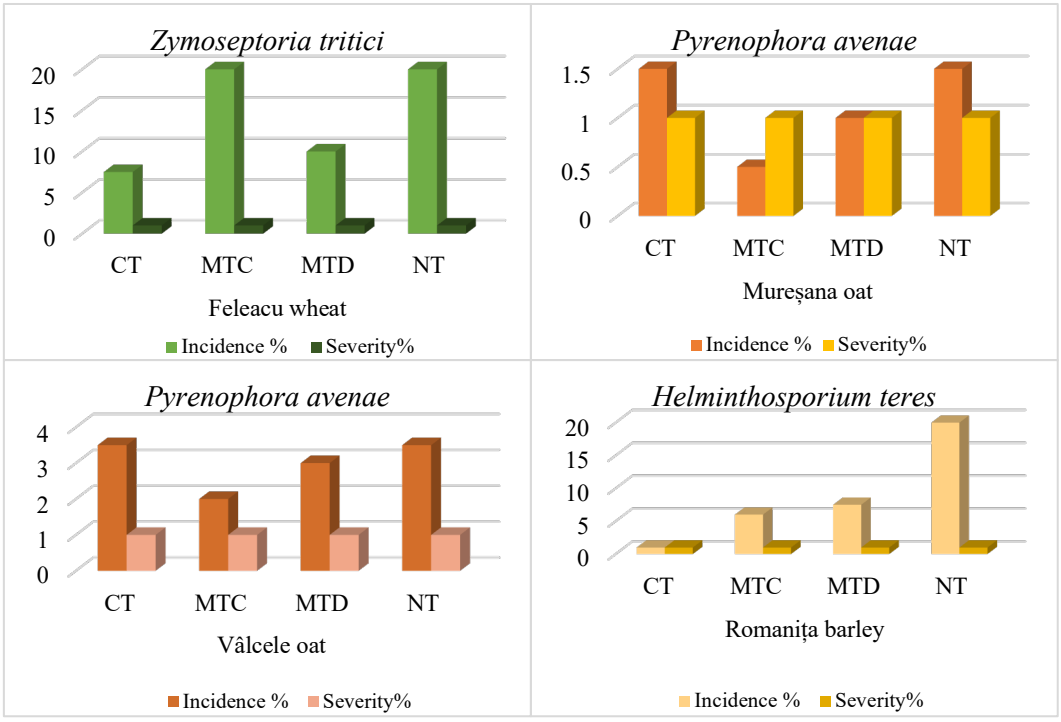

Figure 2. Incidence and severity of major foliar diseases in wheat, oat and barley under different soil management systems

The data from Table 2 indicate that the abundance of phytophagous arthropods was strongly influenced by the soil tillage system, with a noticeable increase in their numbers in the MTC, MTD and NT. The wheat thrips (*Haplothrips tritici*), a pest frequently encountered in cereal crops, showed high abundance values in the conservative systems, particularly in wheat, where the highest abundance was recorded in the NT system.

The order Diptera was best represented by the family Chloropidae, which exhibited a high abundance in minimum-tillage systems, suggesting that this type of soil management favors the development of these pests by ensuring more stable environmental conditions and reduced soil disturbance. Likewise, coleopteran species (*Phyllotreta vittula, Chaetocnema aridula, Oulema melanopus, Sitona lineatus*) generally showed higher densities in conservative systems, indicating that these conditions favor overwintering and pest survival. This may lead to intensified attacks during the early developmental stages of the crops.

In the case of the order Hemiptera, the families Aphididae and Cicadellidae were well represented showing high abundances across all crops, with the highest values in wheat under the CT system. This uneven distribution suggests that their density was influenced more by local climatic conditions than by the soil tillage system.

Table 2. Abundance of phytophagous arthropod fauna in cereal crops

Pest (species/taxonomic group)	Crop/Tillage system/pest number											
	Wheat				Barley				Oat			
	CT	MTC	MTD	NT	CT	MTC	MTD	NT	CT	MTC	MTD	NT
Thysanoptera/*Haplothrips tritici*	27	6	79	85	12	22	44	24	12	32	19	19
Diptera / Chloropidae	34	18	19	65	220	199	232	104	197	216	141	290
Diptera / Anthomydae	2	-	3	1	4	1	-	-	3	2	-	-
Other Diptera	-	7	-	2	-	-	-	-	6	5	8	5

Coleoptera / *Phylotretra vitulla*	41	22	59	53	12	8	19	18	5	4	2	1
Coleoptera /*Chaetocnema aridula*	9	11	21	17	13	10	24	14	26	7	8	8
Coleoptera /*Oulema melanopus*	20	19	11	17	3	3	8	6	4	4	4	6
Coleoptera / *Sitona lineatus*	2	3	-	3	-	2	1	3	3	-	1	-
Coleoptera /Curculionidae	-	2	3	-	3	2	-	4	3	-	-	5
Coleoptera / Elateridae	-	-	-	1	-	1	-	-	-	1	-	-
Hemiptera / Aphididae	66	65	56	37	22	27	49	53	49	34	40	20
Hemiptera / Cicadellidae	18	16	9	16	20	30	33	13	9	15	15	18
Hemiptera / *Lygus* sp.	12	4	6	6	2	-	1	-	-	3	-	1
Hemiptera / *Aelia* sp., *Eurygaster* sp.	2	4	4	2	-	1	1	-	2	2	1	-
Hymenoptera - *Cephus pygmeus, Trachelus* sp.	3	5	8	4	1	2	1	1	-	-	-	-

The analysis of entomophagous fauna reveals different dynamics among systems and crops (Table 3), providing additional insight into the potential for natural pest regulation.

Table 3. Abundance of entomophagous arthropod fauna in cereal crops

Enthomophagous (species/taxonomic group)	Crop/Tillage system/pest number											
	Wheat				Barley				Oat			
	CT	MTC	MTD	NT	CT	MTC	MTD	NT	CT	MTC	MTD	NT
Coleoptera - Coccinellidae	3	1	1	-	4	4	2	1	4	2	3	-
Coleoptera - Cantharidae	3	2	3	3	1	2	-	-	1	-	-	-
Coleoptera - Malachiidae	-	-	-	1	-	-	-	1	-	1	-	-
Coleoptera - Staphylinidae	8	3	2	-	-	2	-	-	-	3	1	1
Hemiptera - Nabidae	-	-	-	-	1	-	1	-	-	-	-	-
Diptera - Syrphidae	3	9	2	16	2	1	3	5	3	6	4	4
Diptera - Empididae	-	-	-	-	7	4	6	2	1	4	1	-
Diptera - Hybotidae	29	37	25	29	13	17	28	21	38	12	9	14
Hymenoptera - *Collyria* sp	1	1	1	4	-	1	-	-	-	-	-	-
Other parasitic hymenoptera	2	6	-	2	1	1	1	4	4	6	4	7
Hemiptera - *Cercopis vulnerata*	4	-	-	-	1	3	1	-	-	-	1	1
Araneae	13	18	13	11	10	7	10	12	14	20	14	16

Diptera represented one of the main predator groups in the analyzed crops. Species of Hybotidae recorded the highest abundance, particularly in the MTC and MTD systems. Also, species of Syrphidae, important aphid predators in the larval stage, showed moderate to high abundances, especially in the NT and MTC systems.

Within the entomophagous Coleoptera, species of the family Coccinellidae were present in all crops, with slightly higher values in conventional systems, while species from the families Cantharidae and Staphylinidae showed low densities, without a clear pattern related to the tillage system. Their consistent presence suggests a stable role in biological control, even if at low densities.

Additionally, a consistent presence of species from the order Araneae was observed, with higher abundances in the MTC and MTD systems, particularly in oat and wheat.

The results show that tillage systems have a significant impact on the phytophagous and entomophagous arthropod fauna in cereal crops. Conservative systems tend to promote a higher abundance of certain pest species, while at the same time supporting increased populations of natural predators such as Hybotidae, Syrphidae, Coccinellidae and Araneae. This coexistence highlights the need for balanced management strategies in which conservation practices are combined with effective monitoring to ensure natural pest regulation and sustainable agricultural production.

Based on the data from Table 2, Figure 3 shows the abundance of phytophagous arthropods at the order level, highlighting the differences among the four tillage systems. Pest populations from orders such as Diptera, Coleoptera, and Thysanoptera recorded higher values under conservation tillage systems (MTC, MTD, and NT), which may increase the risk of crop damage in the absence of effective integrated pest management measures. Additionally, the variations observed among the three cereal crops emphasize the need to adapt plant protection strategies according to the pest species, crop type, and tillage system applied.

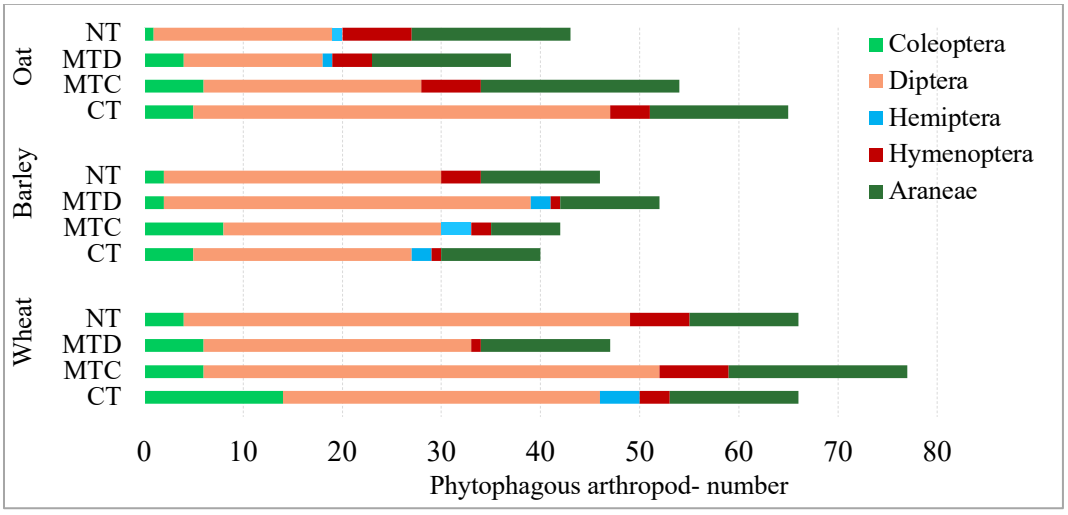

Figure 3. Abundance of phytophagous arthropod orders in cereal crops under different tillage systems

In all analyzed crops, the order Diptera represented the main group of entomophagous arthropods, with high values especially in the MTC and MTD systems. The order Araneae also showed a consistent presence and relatively elevated values, particularly in the NT and MTC systems. In contrast, the orders Coleoptera and Hymenoptera recorded lower values, although they appeared consistently across all crops and tillage systems (Figure 4).

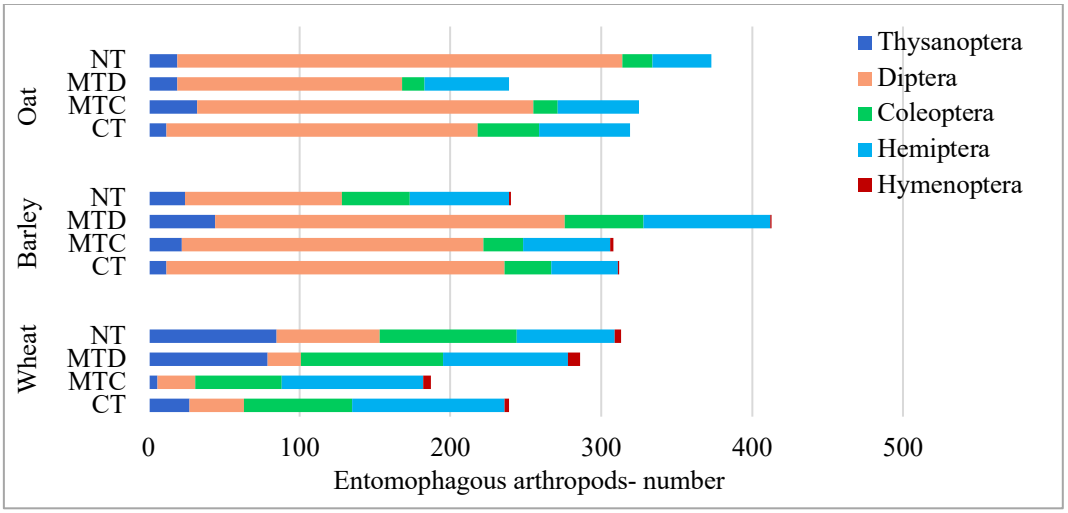

Figure 4. Abundance of entomophagous arthropod orders in cereals crops under different tillage systems

Regarding the yield obtained, between the unconventional soil tillage systems and the conventional system, variable differences (more or less accentuated, depending on the species) were observed, according to the data presented in Table 4.

Table 4. The influence of the tillage system on the spring cereals yield, 2024-2025

The species (B)/tillage system (A)		Yield (kg/ha)	Differences ± kg/ha	Significance
b_1, Feleacu wheat	a_1, CT	4670	0	control
	a_2, MTC	4556	-114	-
	a_3, MTD	4414	-255	0
	a_4, NT	3994	-676	000
LSD (p 5%) = 95; LSD (p 1%) = 143; LSD (p 0.1%) = 230.				
b_2, Mureșana oat	a_1, CT	3971	0	control
	a_2, MTC	4070	99	-
	a_3, MTD	4129	158	-
	a_4, NT	4237	266	*
LSD (p 5%) = 191; LSD (p 1%) = 289; LSD (p 0.1%) = 465				
b_3, Vâlcele oat	a_1, CT	4480	0	control
	a_2, MTC	4360	-120	-
	a_3, MTD	4294	-185	-
	a_4, NT	4200	-279	0
LSD (p 5%) = 198; LSD (p 1%) = 300; LSD (p 0.1%) = 482.				
b_4, Romanița barley	a_1, CT	5063	0	control
	a_2, MTC	4946	-118	-
	a_3, MTD	5336	273	*
	a_4, NT	5028	-35	-
LSD (p 5%) = 230; LSD (p 1%) = 348; LSD (p 0.1%) = 559.				

For wheat, the highest yields were recorded in variants with deeper soil mobilization (CT and MTC), while MTD and NT systems showed negative influence, reflected in decreases of 255 kg/ha and 676 kg/ha, respectively.

In Mureșana oats, the differences between systems varied between 99 and 266 kg/ha, with the NT system achieving the highest yields; the positive difference of 266 kg/ha is statistically significant.

In the case of Vâlcele oats, the yields obtained were relatively close between the work systems, except for the NT system, where there was a decrease of 279 kg/ha (significantly negative influence) compared to the control variant (CT 4480 kg/ha; NT 4200 kg/ha).

In barley, high yields were obtained in all soil working systems, the MTD system being distinguished by a significantly positive influence, illustrated by a difference of 273 kg/ha (5336 kg/ha). These results suggest that, among the analyzed species, barley had the lowest requirements for the degree of soil mobilization.

Analyzing the average of the experimental years (Table 5), that overall yields were lower in 2025, with crops affected by climate conditions.

Compared to the control variant, the statistically significant yield differences (623 kg/ha) were recorded only at Vâlcele oat, with a very significant positive effect in 2024 and a negative in 2025. The crops were affected by low temperatures (accompanied by frost and snow) recorded in the first decade of April, the most pronounced impact being observed in oats. The climatic conditions in spring 2025 also significantly influenced the plant tillering process, but the barley was the least affected, which was clearly reflected in the yield data.

Table 5. The influence of the year (climatic condition) on the spring cereals yield, 2024-2025

The species (B)/year (C)		Yield (kg/ha)	Differences ± kg/ha	Significance
b_1, Feleacu wheat	c_0, mean	4407	0	control
	c_1, 2024	4335	-72	-
	c_2, 2025	4479	72	-
LSD (p 5%) = 80; LSD (p 1%) = 117; LSD (p 0.1%) = 175.				
b_2, Mureșana oat	c_0, mean	4104	0	control
	c_1, 2024	4223	119	-
	c_2, 2025	3983	-119	-
LSD (p 5%) = 195; LSD (p 1%) = 284; LSD (p 0.1%) = 426.				
b_3, Vâlcele oat	c_0, mean	4333	0	control
	c_1, 2024	4956	623	***
	c_2, 2025	3708	-623	000
LSD (p 5%) = 164; LSD (p 1%) = 238; LSD (p 0.1%) = 358.				
b_4, Romanița barley	c_0, mean	5094	0	control
	c_1, 2024	5214	120	-
	c_2, 2025	4972	-122	-
LSD (p 5%) = 121; LSD (p 1%) = 176; LSD (p 0.1%) = 264.				

CONCLUSIONS

Foliar diseases had a minimal impact, with very low incidence and severity across all species, due to the combined effect of seed treatment, fungicide applications, and ploughing practices, which effectively limited pathogen development and spread.

The results show that soil tillage systems influence the abundance of both phytophagous and entomophagous arthropods, and that conservation systems, although favoring certain pest species, also support the populations of natural predators.

The application of pest control treatments represents a critical technological step, as does the selection of the optimal timing for prevention and intervention. The treatments

applied during the late tillering and booting stages of the species included in the experiment significantly reduced pest abundance.

The results highlight both the effectiveness of applied treatments in controlling diseases and the adaptability of grain to cultivation in unconventional soil tillage systems.

Of the three species analyzed (wheat, oat and barley), barley turns out to be the least sensitive to the soil tillage system, constantly producing about 5000 kg/ha annually.

In the current context, climate conditions remain the main determining factor in production formation.

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