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BEHAVIOR OF WHEAT UNDER DIFFERENT TILLAGE SYSTEMS IN THE PEDOCLIMATIC CONDITIONS OF THE TRANSYLVANIAN PLATEAU

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Abstract

Modern agriculture's challenges are being addressed by implementing agricultural methods that improve the soil's condition and decrease CO_2 emissions. Through the research carried out at the Agricultural Research and Development Station Turda we aim to highlight, by comparison with the conventional system (CS- plough) the effectiveness of unconventional tillage systems (MTC- chisel, MTD- disk, NT- direct sowing) at winter wheat cultivation, in the soybean-wheat-maize rotation, from the perspective of technological implications. The experience is organized according to the subdivided plots method, with two replications. The biological material used in this experiment is the „Andrada” winter wheat variety. In the 11 vegetation periods (2013/2014……2023/2024), the average of winter wheat yield was highest in the MTC system (6,662 kg/ha), but with an increase in yield below 100 kg/ha compared to CS. Even though in the MTD and NT systems the yield is lower than in the CS, these systems, in addition to the benefits they have on the properties of the soil, also represent a way towards better economic efficiency. Sustainable development principles must be adhered to when adopting unconventional soil tillage systems, considering plant requirements and favorable climate and soil conditions.

Key words: *climate, fertilization, tillage system, wheat, yield.*

INTRODUCTION

The degradation of agricultural land, greatly intensified in recent years, represents a real problem worldwide. Anthropogenic activity contributes greatly to the worsening of soil properties, with negative effects on biodiversity, productivity, and food security (Lee, 2005; Drury et al., 2006; DeLong et al., 2015).

Numerous studies and research carried out, including Lehman et al. (2015), specify the need to implement immediate measures to contribute as much as possible to restoring soil health. Agriculture needs to adapt to new technological trends in the way the land is processed in order to set up crops (Karlen & Rice, 2015; Lal et al., 2020). Unconventional soil tillage systems are considered viable alternatives to the ploughing system (with furrow turning), protect the soil from erosion, improve the infiltration and conservation of rainfall water, effects mentioned by Cantero-Martínez et al. (2007), Moraru et al. (2010) and Cociu & Cizmaș (2015). Minimum tillage and no tillage technologies have expanded (Derpsh et al., 2010), and herbicides have taken a large part of the contribution of soil works in weed control, and here we refer to moldboard plowing, cultivators, disk harrow, rotating spading (Colbach & Cordeau, (2022). Importance of herbicides for no till agriculture in South America. Crop life. Retrieved from https://croplife.org/case-study/importance-of-herbicides-for-no-till-agriculture-in-south-america/).

These technologies can lead over time to obtaining productions close to those obtained in the conventional variant with plowing, but also to increasing the degree of flowering, with perennial species in particular (Berca, 2004; Chețan et al., 2022).

For the adoption of the unconventional soil work system, high-performance machines are needed, which have quite high costs (Chețan, 2019). Their use leads to significant fuel savings

(Kőller, 2003; Marin et al., 2015; Chețan & Chețan, 2020a), favorably influencing the cost of production (Tihanov & Ivanov, 2021).
Wheat belongs to the most cultivated cereals group in the world, according to Erenstein et al. (2022), the areas occupied by wheat being currently 217 million hectares. In wheat crop, one of the most important links in cultivation technology is weed control and is based primarily on knowledge of sources of soiling, biological characteristics of weeds, multiplication, spread, etc. (Tsyuk et al., 2021).
According to certain authors, in agricultural crops, dicotyledonous weeds predominate (Ionescu, 2011; Rusu et al., 2013; Stănilă et al., 2013; Steponavičienė et al., 2021; Manilov, 2022). In the wheat crop, the degree of enrichment is primarily due to the high reserve of seeds in the soil, but also to the fact that this plant has relatively low power to compete with weeds. A high degree of weeding can delay plant development and reduce the production quantitatively and qualitatively (Young et al., 1994; Harasim et al., 2014). There are various sources through which diseases and pests spread. For example: *Uromices pissi* thrives on *Euphorbia cyparissias*; and *Puccinia triticine* thrives on weeds from the *Gramineae* family (Pfunder et al., 2000; Bolton et al., 2008).
In recent years, climate conditions, characterized by high temperatures and low rainfall, have been less favorable to the successful establishment of autumn crops.
Due to unfavorable climatic factors, sowing was delayed in most areas of the country, resulting in an uneven growth of crops. This has led to a vulnerability to weed competition and sensitivity to pest attack. Among the autumn wheat varieties created in Turda is the 'Andrada' variety, characterized by an increased tolerance to environmental stressors, which, here we refer in particular to the temperature variations between night and day and the unevenness of precipitation (Moldovan et al., 2012).
The paper presents the results of the research carried out at the Agricultural Research and Development Station (A.R.D.S.) Turda, in the climatic conditions specific to the 11 agricultural years of experimentation (2013/2014…….2023/2024). The purpose of the study was to establish the influence of four types of soil tillage and two levels of fertilization on the winter wheat yield.

MATERIALS AND METHODS

The experimental field is located in the Western part of the Transylvanian Plateau, in the Southern part of Cluj County. The experiment was established on a Phaeozem soil (S.R.T.S, 2012), with clay-clay texture (M.E.S.P, 1987), pH slightly alkaline, medium supply level with total N and P, good supply with K, and moderate content in humus (Chețan & Chețan, 2020b). The crop rotation is three years, namely: maize-wheat-soybean. The biological material was the 'Andrada' variety.
The experimental factors were the following:
- A, soil tillage system with four graduations: conventional with plow (CS), minimum tillage with chisel (MTC), minimum tillage with disk (MTD), and no tillage with direct sowing (NT);
- B, fertilization level with two graduations: basic fertilization with $N_{48}P_{48}K_{48}$; basic fertilization with $N_{48}P_{48}K_{48}$ + in the spring when the wheat vegetation resumes with $N_{40.5}CaO_{10.5}MgO_{7.5}$;
- C, agricultural year with 11 gradations: 2013/2014…….2023/2024.

Wheat sowing in all tillage systems was done with the Directa-400 seeding machine; the sowing density was 550 germinating grains/m^{2,} and the distance between the rows was 18 cm. The crop before winter wheat was soybeans, which were harvested relatively late; therefore, wheat sowing took place in the first decade of November of each experimental year. The particular importance of the technology of growing wheat, and not only, is the fight against weeds. In this experiment weed species were identified: annual dicotyledons (AD) like *Xanthium strumarium, Chenopodium album, Fallopia convolvulus, Polygonum arenastrum, Capsella rubella, Veronica persica, Sonchus oleraceus, Papaver dubium, Galeopsis bifida, Galium spurium, Consolida regalis, Myosotis arvensis, Stellaria media, Viola arvensis, Hibiscus trionum, Amaranthus retroflexus, Fumaria officinalis, Geranium dissectum, Galinsoga parviflora, Stachys annua, Anagallis arvensis*; perennial dicotyledons (PD) like *Convolvulus arvensis, Rubus caesius, Cirsium arvense, Taraxacum officinale, Rorippa* *armoracioides, Lathyrus tuberosus, Symphytum bohemicum, Achillea millefolium, Lepidium draba*; annual monocotyledons (AM) like *Setaria helvola, Echinochloa hispidula, Avena fatua, Bromus tectorum* and perennial monocotyledons (PM) like *Elymus repens*.

Through the crop rotation practiced at A.R.D.S Turda, winter wheat follows the soybean crop (which is harvested quite late, in the first decade of November), thus, the number of weeds that appear in the newly established crop is quite small, and weed competition is reduced, herbicide application in autumn is not necessary. Account shall be taken of the observance of preventive measures, in the first place, crop rotation, the use of certified seeds, sowing data, sowing density, etc. These preventive measures are supplemented with chemical treatment at the end of the tillering phenophase of wheat, for controlling grasses and broad-leaf weeds. In this case, the treatment was carried out with 260 g/ha produced based on two active ingredients: florasulam (14.2 g/kg) + pyroxsulam (70.8 g/kg). To improve the effectiveness of the herbicide on weeds, 0.6 liters/ha of an adjuvant were applied.

The experimental field was harvested annually in the last decade of July, with the combine for harvesting experimental plots.

The yield was determined by weighing on the experimental parceling, after having eliminated the margins and transformed according to 14% STAS humidity (Cheţan et al., 2023).

The statistical analysis of the yield was performed using stability parameters based on the method proposed by Eberhart & Russell (1966) and also through cluster analysis using the Past4 Statistical Program.

Tables 1 and 2 present the climatic conditions recorded during the experimental period, in the Turda ARDS area measured by the Turda Meteorological Station (23'47'longitude; 46'35'latitude; 427 m altitude). The average value of multiannual temperatures recorded over a period of 67 years is 9.3°C, and that of precipitation is 532.4 mm. Regarding the thermal regime, it can be observed (Table 1) that in most agricultural years in which the study was conducted, with the exception of 2021, a warming trend in the average air temperature is observed; in some years, the 67-year multiannual average (9.9°C) was exceeded. In terms of the rainfall regime, higher amounts of precipitation, over 600 mm, were recorded in five years (2014, 2015, 2016, 2020, 2023); the excessively dry year was 2024 with only 389 mm (Table 2). Specific to the Turda area is the uneven distribution of precipitation. After long periods of drought, the rainfall that occur have a torrential character and are sometimes accompanied by strong winds and hail.

Table 1. Temperature in the agricultural years 2013/2014......2023/2024 at the A.R.D.S. Turda

Month	**Temperature (°C) - agricultural year**											
	2013/ 2014	**2014/ 2015**	**2015/ 2016**	**2016/ 2017**	**2017/ 2018**	**2018/ 2019**	**2019/ 2020**	**2020/ 2021**	**2021/ 2022**	**2022/ 2023**	**2023/ 2024**	**67 years**
October	11.2	10.8	9.7	8.3	11.6	12.7	13.5	12.0	9.7	12.4	14	**9.8**
November	7.1	5.7	6.1	2.9	4.9	6.0	8.9	3.2	4.4	5.4	5.2	**4.0**
December	-1.7	1.3	0.7	-2.7	1.0	-0.9	0.8	2.7	0.9	1.6	1.2	**-1.3**
January	0.5	-0.7	-2.8	-6.7	0.2	-2.2	-2.8	-0.6	-1	2.8	0.2	**-3.3**
February	3.8	0.6	4.6	1.5	-0.3	1.7	2.6	1.4	2.2	0.5	7.0	**-0.6**
March	8.8	5.5	5.9	8.4	3.3	7.3	6.1	3.3	3.6	6.3	8.8	**4.4**
April	11.4	9.6	12.4	9.9	15.3	11.3	10.3	7.8	8.8	8.8	13.3	**10.4**
May	15.1	15.8	14.3	15.7	18.7	13.6	13.7	14.1	16.3	15.4	15.8	**15.0**
June	18.5	19.4	19.8	20.7	19.4	21.8	19.1	19.8	21.1	19.0	21.7	**18.0**
July	20.4	22.2	20.5	20.3	20.4	20.4	20.2	22.7	23.1	21.8	24.0	**19.8**
Average	**9.51**	**9.02**	**9.12**	**7.83**	**9.45**	**9.17**	**9.24**	**8.64**	**8.91**	**9.4**	**11.12**	**9.3**

Table 2. The rainfall in the agricultural years 2013/2014......2023/2024 at the A.R.D.S. Turda

Month	**Precipitation (mm) - agricultural year**											
	2013/ 2014	**2014/ 2015**	**2015/ 2016**	**2016/ 2017**	**2017/ 2018**	**2018/ 2019**	**2019/ 2020**	**2020/ 2021**	**2021/ 2022**	**2022/ 2023**	**2023/ 2024**	**67 years**
October	37.6	67.4	45.4	152.2	49.2	26.8	25.6	53.6	11.6	35.4	19.8	**35.4**

November	44.0	34.2	32	45.3	30.8	29.6	28.4	17.1	20.5	28.2	43.6	**28.2**
December	57.8	86.6	6.9	7.2	20.7	58.3	14.2	22.5	47.9	27.6	17.8	**27.6**
January	51.6	12.3	25	2.6	16.7	46	10.4	27	21.7	42.7	4.8	**21.7**
February	15.5	20.9	23.8	19.2	33.4	14.7	37.4	16.4	19.2	27.1	9.2	**19.2**
March	23.1	12.8	47	46.1	40.9	12.3	34	27.3	24.2	10.8	37.7	**24.2**
April	72.0	32.2	62.2	65.2	26.2	62.6	17.8	38.4	45.6	30.5	38.8	**45.6**
May	66.2	66	90.4	65.4	56.8	152.4	44.4	80.8	69.4	33.2	60.7	**69.4**
June	48.4	115.7	123.2	30.6	98.3	68.8	166.6	45.0	84.6	144.5	36.2	**84.6**
July	144.4	52.2	124.9	110.2	85.7	35	86.8	123.1	78	85.8	49.3	**78.0**
Sum	**560.6**	**500.3**	**580.8**	**544**	**458.7**	**506.5**	**465.6**	**451.2**	**422.7**	**465.8**	**317.9**	**532.4**

RESULTS AND DISCUSSIONS

The yield capacity of the winter wheat, „Andrada" variety, demonstrated considerable variation, being influenced by the two technological factors studied: the soil tillage system and the level of fertilization. As can be seen from Figure 1, throughout the 11 years of experimentation, average yields ranged from 6,156 kg/ha, achieved with the no-tillage (NT) system and basic fertilization, to 6,666 kg/ha, obtained under the conventional plowing system with additional fertilization.

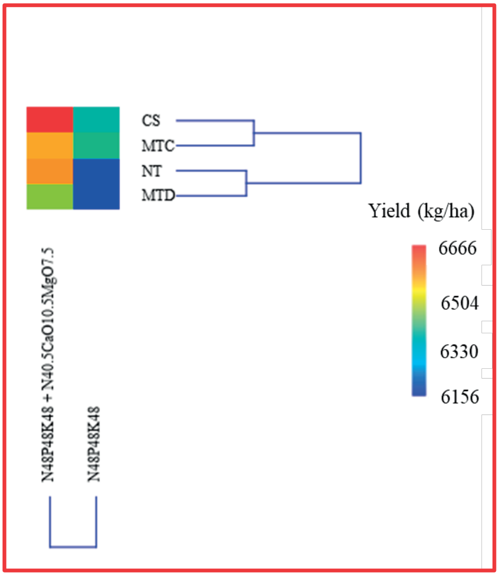

Figure 1. The yield potential of the winter wheat, based on the soil tillage system and fertilization levels

The result clearly indicates the significant impact of fertilization on wheat yield, with higher yield observed in treatments where additional fertilization was applied, regardless of the soil tillage method. Regarding the tillage system, the conventional system with plow (CS) and minimum tillage with chisel (MTC) yielded higher results compared to the other two tillage variants (MTD, NT). Similar results were reported by Chiriță et al. (2023), who pointed out that the higher yield was obtained in CS (7,148 kg/ha) and in MTC (6,662 kg/ha). It also mentions that in MTD and NT systems, the yield was 533 kg/ha, respectively 633 kg/ha lower compared to the CS variant.

The results obtained by Gandía et al. (2021), in an experiment with three tillage systems (conventional, minimum, no-tillage) in the 2014-2017 period, highlight the fact that the soil cultivation system did not significantly influence the wheat yield, the greatest influence being attributed to the precipitation regime.

When analyzing the influence of the year and the soil tillage system on the wheat yield obtained (Figure 2), it is evident that climatic conditions played a significant role in achieving high yields, regardless of the tillage system used.

The years 2014, 2015, and 2016 allowed the studied genotype to reach the highest yield in the experiment, exceeding 7,200 kg/ha obtained in both the CS and the MTC. Conversely, the year 2022, characterized by adverse thermal and hydric conditions, resulted in a decline in yield, with a reduction to approximately 3,500 kg/ha (MTD and NT).

Yields above 6,000 kg/ha were recorded in the conventional plowing system during the 2017, 2019, and 2024 growing seasons. The heat map analysis further illustrates that the year had a more substantial effect on yield variation than the technological factor of the soil tillage system.

The analysis of the interaction between fertilization and the crop year on grain yield for the winter wheat emphasizes the critical role of climatic conditions in achieving substantial yield increases, alongside the influence of fertilization practices.

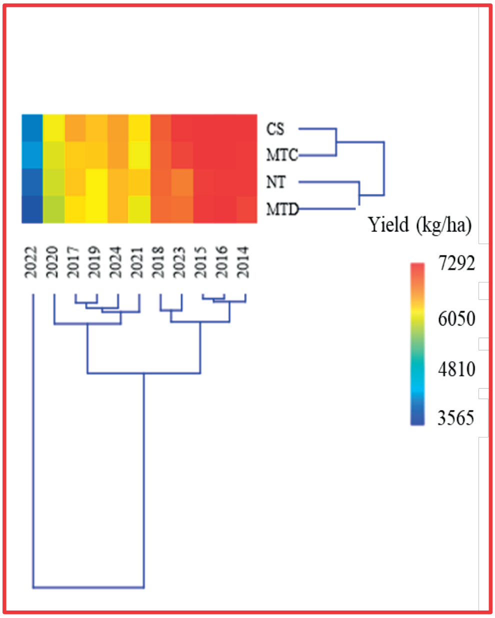

Figure 2. The yield potential of the winter wheat, based on the soil tillage system, in 11 different agricultural years

The additional fertilization resulted in higher yield across all experimental years.

Notably, the lowest yield (4,022 kg/ha) was observed in 2022, under treatment with only base fertilization. The highest yield, 7,402 kg/ha, was recorded in 2015, when supplemental fertilization was applied, as can be seen from Figure 3.

Based on the analysis of the production stability of the winter wheat, variety 'Andrada', over an 11-year period, considering different soil tillage systems and fertilization levels, it is evident that the conventional plowing system (CS) demonstrates superior performance under favorable environmental conditions, while the minimum tillage system with chiseling (MTC) shows higher values than plowing under unfavorable environmental conditions. Although yields from minimum tillage (MTD) and no-tillage systems (NT) are slightly lower, they remain acceptable, exceeding 6,400 kg/ha in favorable environmental conditions. anticipated, higher nutrient input results in greater yields compared to baseline fertilization (Figure 4).

From the study conducted by Aula et al. (2023) in the long-term experiment (initiated in 1970) regarding the grain yield under different tillage systems (no tillage, stubble mulch, moldboard plow), results show a more stability yield in the stubble mulch tillage system compared with no tillage and moldboard

plow. Contrary, Seddaiu et al. (2016) and Xu et al. (2019) showed that no tillage may lead to a more stable grain yield than the conventional tillage system.

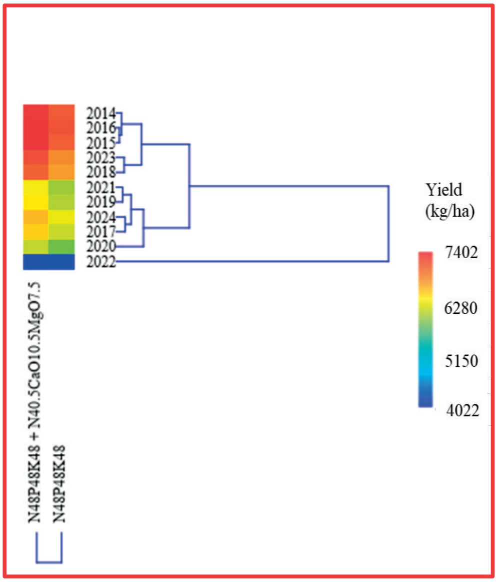

Figure 3. The yield potential of the winter wheat, based on fertilization levels, in 11 different agricultural years

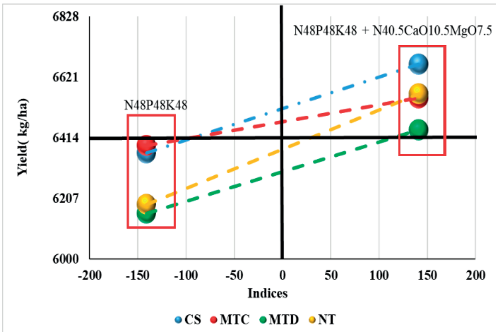

Figure 4. The yield stability of winter wheat, based on fertilization levels and tillage system, in 11 different agricultural years

CONCLUSIONS

Specific to the 11 years of experimentation was the uneven distribution of precipitation and high temperatures; in the specific area of the Transylvanian Plateau, production is closely linked to the climatic conditions of the vegetation period.

Tillage has a lower impact on wheat production, with production differences of almost 200 kg/ha, indicating that unconventional systems can be an alternative to the conventional tillage system.

Additional fertilization, against the backdrop of meteorological changes in most experimental years, did not lead to substantial increases in production; the results obtained can contribute to the existing data in the specialized literature on winter wheat cultivation technologies in the Transylvanian Plateau.

The conventional tillage system (CS) remains a viable option in terms of soil cultivation, achieving higher yields under favorable environmental conditions, while the minimum tillage system with chisel plow (MTC) records higher production values under unfavorable environmental conditions.

Although yields from the minimum tillage (MTD) and direct seeding (NT) systems are slightly lower, they remain acceptable, exceeding 6,400 kg/ha under favorable environmental conditions.

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REFERENCES

Aula, L., Mikha, M. M., Easterly, A. C., & Creech, C. F. (2023). Winter wheat grain yield stability under different tillage practices. *Agronomy Journal*, 115(2), 1006–1014. https://doi.org/10.1002/agj2.21236.

Berca, M. (2004). *Integrated weed management*, Ed. Ceres, Bucharest.

Bolton MD, Kolmer JA, Garvin DF. (2008). Wheat leaf rust caused by *Puccinia triticina*. *Mol Plant Pathol*., Sept.; 9(5): 563-75. doi: 10.1111/j.1364-3703.2008.00487.x. PMID: 19018988; PMCID: PMC6640346.

Cantero-Martínez, C., Angás, P., Lampurlanés J. (2007). Long-term yield and water use efficiency under various tillage systems in Mediterranean rainfed conditions. *Ann Appl. Biol*., 150: 293–305. doi:10.1111/j.1744-7348.2007 203.

Cheţan F., Rusu T., Cheţan C., Şimon A., Vălean A. M., Ceclan A.O., Bărdaş M., Tărău A. (2023). Application of unconventional tillage systems to maize cultivation and measures for rational use of agricultural lands. *Land* 2023, *12*(11), 2046; https://doi.org/10.3390/land12112046

Cheţan, F. (2019). The influence of the tillage system and the crop rotation on the soil availability in the main nutrients and the yields obtained in Turda area. *Scientific Papers. Series A. Agronomy*, *LXII*(1), 19–23.

Cheţan, F., Calistru, C., Chiriţă, S., Cheţan, C. (2022). Influence of agricultural system on the control of *Bromus tectorum* on winter wheat. *Journal Life Science and Sustainable Development*, Vol. 3, no. 1, Lovrin Agricultural Research and Development Station, România. https://www.lssd-journal.com

Cheţan, F., Cheţan, C. (2020a). The identifying some technological measures to efficiency soybean cultivation in the Transylvanian Plain. ISB INMA TEH. *International symposium Agricultural and Mechanical Engineering*, Jubilee Edition, Bucharest, 30 October 2020, p: 86-92, Edited by: INMA Bucharest.

Cheţan, F., Cheţan, C. (2020b). Researches regarding the influence of the unconventional soil tillage systems upon weeding and soybean yield, in pedoclimatic conditions in the Transylvanian Plain. In: Agrarian Economy and Rural Development-Realities and Perspectives for Romania; *Volume of International Symposium ICEADR*: Bucharest, Romania, 2020; Volume 11, pp. 91-99. Available online: https://symposium.iceadr.ro (Accessed on 2/24/2025).

Chiriţă, S., Rusu, T., Urdă, C., Cheţan, F., Racz, I. (2023). Winter wheat yield and quality depend on chemical fertilization, different treatments, and tillage systems. *AgroLife Scientific Journal*, 12(1), 34–39. https://doi.org/10.17930/AGL202315

Cociu, A., Cizmas. G.D. (2015). Maize yield and its stability as affected by tillage and crop residue management in the eastern Romanian Danube Plain. *AgroLife Scientific Journal*, 4(1), 46–51. https://agrolifejournal.usamv.ro/index.php/agrolife/article/view/385/381

Colbach, N., Cordeau, S. 2022. Are No-Till Herbicide-Free Systems Possible? A Simulation Study. Front. Agron. 10 May 2022. Sec. *Agroecological Cropping Systems.* Vol. 4. https://doi.org/10.3389/fagro.2022.823069 (Accessed on 2 24.2025).

DeLong, C., Cruse, R., Wiener, J. (2015). The Soil Degradation Paradox: Compromising Our Resources When We Need Them the Most. *Sustainability,* 7, 866–879.

Derpsch, R., Friedrich, T., Kassam, A., Hongwen, L. (2010). Current status of adoption of no-till farming in the world and some of its main benefits. *Int. J. Agric. & Biol. Eng*., *3*(1): 1-25.

Drury, C.F., Reynolds, W.D., Tan, C.S., Welacky, T.W., Calder, W., McLaughlin, N.B. (2006). Emissions of nitrous oxide and carbon dioxide: Influence of tillage type and nitrogen placement depth. *Soil Sci. Soc. Am. J*. 2006. 70. 570–581.

Eberhart, S.A., Russell, W.A. (1966). Stability parameters for comparing varieties. *Crop Sci*., 6: 3640

Erenstein, O., Jaleta, M., Mottaleb, K.A., Sonder, K., Donovan, J., Braun, H.J. (2022). Global Trends in Wheat Production, Consumption and Trade. In: Reynolds, M.P., Braun, H.J. (eds) *Wheat Improvement.* Springer, Cham. https://doi.org/ 10.1007/ 978-3-030-90673-3_4 (Accessed on 2/24/2025)

Gaba, S., Gabriel, E., Chadoeuf, J., Bonneu, F., Bretagnolle, V. (2016). Herbicides do not ensure for higher wheat yield, but eliminate rare plant species. *Sci. Rep*., 2016, 6, 30112. https://www.nature.com/articles/srep30112

Gandía, M.L., Del Monte, J.P., Tenorio, J.L., Santín-Montanyá, M.I. (2021). The influence of rainfall and tillage on wheat yield parameters and weed population in monoculture versus rotation systems. *Sci Rep*, 11, 22138. https://doi.org/10.1038/s41598-021-00934-y

Harasim, E., Wesołowski, M., Kwiatkowski, C. (2014). The effect of reduced growth retardant rates on weed infestation of a winter wheat (*Triticum aestivum* L.) crop. *Rom. Agric. Res.*, 31, 271–281. https://www.incdafundulea.ro/rar/nr31/rar31.33.pdf

Ionescu, N. (2011). Research on reducing the winter wheat crop weed encroachment. *An. I.N.C.D.A. Fundulea*, vol. LXXIX, no. l. Agrotehnica Culturilor, 89-99. Electronic (Online) ISSN 2067-7758.

Karlen, D. L., Rice, C. W. (2015). Soil Degradation: Will Humankind Ever Learn? *Sustainability* 7, no. 9: 12490-12501. https://doi.org/10.3390/su70912490.

Köller, K. (2003). Conservation tillage-technical, ecological and economic aspects. In *Conservation Tillage and Direct Seeding Workshop*, Izmir, p. 9-34.

Lal, R., Eckert, D.J., Fausey, N.R., Edwards, W. M. (2020). Conservation tillage in sustainable agriculture. In *Sustainable Agricultural Systems*; CRC Press: Boca Raton. FL. USA. 2020; pp. 203–225.

Lee, D.R (2005). Agricultural Sustainability and Technology Adoption: Issues and Policies for Developing Countries. *American Journal of Agricultural Economics*. *Agricultural and Applied Economics Association, 87*(5), 1325–1334.

Lehman, R.M., Cambardella, C.A., Stott, D.E., Acosta-Martinez, V., Manter, D.K., Buyer, J.S., Maul, J.E., Smith, J.L., Collins, H.P., Halvorson, J.J., Kremer, R.J., Lundgren, J.G., Ducey, T.F., Jin, V.L., Karlen, L.K. (2015). Understanding and Enhancing Soil Biological Health: The Solution for Reversing Soil Degradation. *Sustainability*. 7. 988–1027.

Manilov, T. (2022). Broadleaf weed control in winter wheat. *Scientific Papers. Series A. Agronomy*, *LXV*(1), 2022, 410–414.

Marin, D.I., Rusu, T., Mihalache, M., Ilie, L., Nistor, E., Bolohan, C. (2015). Influence of soil tillage upon production and energy efficiency in wheat and maize crops. *AgroLife Scientific Journal,* 4(2), 43–47.

Moldovan, V., Kadar, R., Popescu, C. (2012). The winter wheat variety 'Andrada'. *An. I.N.C.D.A. Fundulea*. *Genetica şi Ameliorarea plantelor*. Vol. LXXX. 21–28. Electronic (online) ISSN 2067–7758. www.incdafundulea.ro

Moraru, P.I., Rusu T., Șopterean M.L. (2010). Soil tillage conservation and its effect on erosion control, water management, and carbon sequestration. *ProEnvironment*, 3. 359–366.

Pfunder M, Roy BA. (2000). Pollinator-mediated interactions between a pathogenic fungus, *Uromyces pisi* (Pucciniaceae), and its host plant, *Euphorbia cyparissias* (*Euphorbiaceae*). *Am J. Bot*., 87(1): 48–55. PMID: 10636829. https://doi.org/10.17930/ AGL2021224

Rusu, T., Bogdan, I., Moraru, P.I., Pop, A.I., Oroian, I., Marin, D.I., Ranta, O., Stanila, S., Gheres, M., Duda, M., Mogosan, C. (2013). Influence of minimum tillage systems on the control of *Convolvulus arvensis* L. on wheat, maize and soybean. *Journal of Food, Agriculture & Environmen*t, *11*(2), 563–566.

Seddaiu, G., Iocola, I., Farina, R., Orsini, R., Iezzi, G., Roggero, P.P. (2016). Long-term effects of tillage practices and N fertilization in rainfed Mediterranean cropping systems: Durum wheat, sunflower and maize grain yield. *European Journal of Agronomy*, 77, 166–178. https://doi.org/10.1016/j.eja.2016.02.008

Stănilă, S., Gheres, M., Duda, M., Mogosan, C. (2013). Influence of minimum tillage systems on the control of *Convolvulus arvensis* L. on wheat, maize and soybean. *Journal of Food, Agriculture & Environment*. 11. 563–56.

Steponavičienė, V., Marcinkevičienė, A., Butkevičienė, L. M., Skinulienė, L., Bogužas, V. (2021). The Effect of Different Soil Tillage Systems and Crop Residues on the Composition of Weed Communities. *Agronomy*, 11(7), 1276. https://doi.org/10.3390/ agronomy11071276

Tihanov, G., Ivanov, N. (2021). Fuel consumption of a machine-tractor unit in direct sowing of wheat. *Agricultural Science and Technology*, *13*(1), 40–42. http://www.agriscitech.eu

Tsyuk, O., Myroshnychnko, M., Tsvey, Y., Melnyk, V. (2021). Control of weeds in agrophytocenosis of winter wheat depending on soil treatment and fertilization system. *AgroLife Scientific Journal*, 10(2), 197–202. https://agrolifejournal.usamv.ro/ index.php/agrolife/article/view/321/320

Xu, J., Han, H., Ning, T., Li, Z., & Lal, R. (2019). Long-term effects of tillage and straw management on soil organic carbon, crop yield, and yield stability in a wheat–maize system. *Field Crops Research*, 233, 33–40. https://doi.org/10.1016/j.fcr.2018.12.016

Young, F.J.L., Ogg Jr., A.G., Papendick, R.I., Thill, D.C., Alldredge, J.R. (1994). Tillage and weed management affect winter wheat yield in an integrated pest management system. *Agron. J*., 86: 147-15410(2).

***SRTS. The Romanian System of Soil Taxonomy; Estfalia: Bucharest, Romania, 2012.
***Methodology for the elaboration of pedological studies. Pedological and agrochemical institutions Bucharest (M.E.S.P.), 1987, Vol. 1-3;
***SR EN ISO 712-1:2024. Cereals and cereal products. Humidity determination. Part 1: Reference method. https://magazin.asro.ro/ro/standard/284269 (Accesed on 2/24/2025)
***Turda meteorological Station longitude: 23'47- latitude 46'35'- altitude 427 m
***https://croplife.org/case-study/importance-of-herbicides-for-no-till-agriculture-in-south-america/
***ANOVA. 2015. PC program for variant analyses made for completely randomized Poly-factorial experiences. UASVM Cluj-Napoca. Romania.