Analele Universităţii din Craiova, seria Agricultură – Montanologie – Cadastru (Annals of the University of Craiova - Agriculture, Montanology, Cadastre Series) Vol. 55/1/2025

THE INFLUENCE OF AGRICULTURAL TILLAGE SYSTEMS AND SOWING DEPTH ON THE DEGREE OF WHEAT EMERGENCE

Denisa Flori GHIȚĂ[1] , Ion SĂRĂCIN[1], Mihnea GLODEANU[1], Sorin BORUZ[1], Ioan Alexandru SĂRĂCIN[1], Emilia CONSTANTINESCU [1]

[1] *University of Craiova, Faculty of Agronomy, Department of MTMM,Str. A.I.Cuza, Nr.13*

Corespondenting autor **: saracin.alex@gmail.com**

Abstract

Soil preparation for wheat crop establishment has a complex influence on its physical, chemical and biological properties, having a direct impact on agricultural production. The present work aimed to analyze the effect of germination bed preparation methods on wheat sowing operations and, subsequently, on the degree of plant emergence. The studies were carried out in the southwest of Dolj County, in Brabova commune, on the lands of an agricultural holding. The experiment was carried out on a total area of 6 hectares, divided into three distinct plots, each of two hectares. The following germination bed preparation and sowing methods were applied on these plots:Plot 1 (TAV): Conventional works for autumn sowing, on a land covered with corn plant residues, followed by a chopping work.,Plot 2 (LDG): Light tillage with heavy disc harrows on a field covered with rapeseed residues.,Plot 3 (LGR): Tillage with a vertical rotor harrow after the sunflower precursor crop had flowered.Immediately after the preparation work, a series of essential soil characteristics were determined for each plot, including: soil moisture, degree of fragmentation, degree of compaction, optimum moisture depth (moisture line) and uniformity of seed embedment depth.

The research will continue throughout the entire vegetation cycle by monitoring the evolution of the crop and will end with the evaluation of the final wheat production obtained.

Key words: tillage methods, TAV, LDG, LGR, seedbe

INTRODUCTION

Tillage systems and seeding depth significantly influence wheat emergence, with deeper seeding generally resulting in lower emergence rates. Conventional tillage can result in more uniform soil properties, while no-tillage systems can increase soil moisture, although this can favour different weed species. The optimal combination therefore depends on soil type, moisture and the specific crop variety used.

Influence of seeding depth

Reduced emergence: Deeper seeding depths consistently result in lower wheat emergence rates.

The ideal seeding depth varies with soil type and moisture levels, with deeper placement being necessary under certain conditions, but shallower seeding can result in faster establishment in moist soil.

Although some studies suggest that wheat can compensate for slower germination with other yield-increasing factors, such as twinning, this does not negate the negative effect of increasing seeding depth on emergence rate itself.

Tillage systems significantly affect soil properties, such as soil bulk density, soil moisture, and water infiltration rate.

No-till systems often result in higher soil moisture content compared to conventional or reduced-till methods, except at harvest time.

Conventional tillage can lead to increased soil compaction over time, while direct tillage can help preserve soil structure.

Different tillage systems favor different types of weed emergence. Conventional systems tend to favor annual dicotyledonous weeds, while direct tillage favors species that can germinate at the soil surface, such as annual monocotyledonous or perennial weeds. Conventional tillage can result in higher available phosphorus in the soil, while reduced-till and no-till systems can have higher levels of potassium and magnesium.

If the soil has consistently low moisture, a no-till system can be beneficial for maintaining moisture, which can improve emergence.

If the soil has compaction problems, a no-till or tilled system helps improve soil structure over time.

The type of tillage can have both negative and positive effects on soil physical properties. Conventional tillage (CT) practices, which involve ridge ploughing, reduce soil organic matter (Troldborg M. et al., 2013) and increase compaction, soil crusting and erosion, also damaging soil biota (Kladivko E.J. 2001; Hösl R. and Strauss P., 2016).

Conventional tillage on sloping areas can lead to high rates of soil loss, especially if carried out in both up- and down-slope directions (DeLaune P.B. and Sij W.J., 2012). This practice results in high rates of erosion (Kisic I. et al., 2017). Therefore, there is a need for more sustainable soil management practices. On the other hand, no-tillage (NT) practices preserve soil quality and reduce soil erosion (Mwango S.B. et al, 2016).

Conventional practices can affect soil physical properties, both positively and negatively (Alvarez R., Steinbach H.S., 2009), leading to highly variable crop yields. Several studies have reported higher crop yields under CT compared to NT (e.g., Van den Putte A. et al, 2010; Tolon-Becerra A. et al, 2011), while others have found no differences.

Changes in soil physical and chemical properties induced by tillage methods directly influence a number of critical factors for microbial activity. These parameters include soil organic matter, moisture, temperature, and aeration, as well as the degree of interaction between minerals and organic compounds. As a result, notable differences in soil microbial populations and activity can occur (Wardle, 1995; Lavelle, 2000; Kladivko, 2001; Sagar et al., 2001).

In the present study, the effects of three distinct tillage methods and seeding depths on plant emergence were analyzed.Choosing the optimal tillage system soil management must be carried out taking into account not only the immediate effects, but also the long-term consequences, so as to ensure high productivity and profitability, in accordance with the principles of environmental protection and conservation of soil and water resources.

Objectives of the study:

• Promotion and expansion of cultivated areas using conservative tillage methods in the analyzed area, based on the results obtained from the experiment;

• Identification of the soil cultivation system that provides the best conditions for germination, growth and development of plants.

MATERIALS AND METHODS

Agricultural Equipment and Facilities

The project or activity is based on the use of agricultural land with a total area of 6 hectares.

Mechanization and Machinery

For soil cultivation and sowing, the following main machinery is available:

Tractor: A CLASS CELTIS 446 model, used as a power source.

Plough: A reversible (or simple) plough of the PP 3-30 type, completed with a star type deflector for better incorporation of plant residues.

Scarifier/Harrow GS-1.2: Probably a scarifier or a light disc harrow, with a working width of 1.2 meters (or a specific model called GS-1.2).

Heavy disc harrow: Type V3, intended for seedbed preparation or stubble incorporation.

Combine/Router: A rotary tiller (power harrow) type GRC 3, used for fine soil crushing and final land preparation.

Seeder: A universal seeder model SUP 29, suitable for large crops (such as wheat).

Biological Material and Parameters

Wheat Variety: The AVENUE wheat variety is used, a key aspect in the crop.

1000 Grain Weight (MMB): The MMB of this variety is specified as 40 grams, an essential value for calibrating the seeder and estimating the seeding density.

To monitor the quality of the soil and the harvested material, precision equipment is used:Moisture meter: A Delta-T Devices Hh2 moisture meter, used to determine the water content of the grains or the soil.

Penetrometer: A Fieldscout SC900 penetrometer, used to assess soil compaction (resistance to penetration) at various depths.

Sieve Sieve Set: Three sieves with aperture diameters of 25 mm, 50 mm and 100 mm respectively, probably used for soil structure analysis or sorting of certain materials.

Sampling Frame: A frame with an area of 1 m², essential for uniform soil sampling or for plant inventory (determining crop Density.

.

Study area

This study was carried out on a soil in the southern part of Dolj County, in the Brabova locality, on an area of 6 hectares, which is part of an agricultural holding. According to the taxonomic classification system of soils, the soils are zonal chernozem, whose properties are presented in table no. 1. The soils are simple and almost simple, inclined 0 + 1% and deeply profiled, located on a very old alluvial subsoil.

Climatic conditions

The land surface, which is located in the transitional temperate-continental climate zone, has a mild winter, with frosty days and nights, along with slightly humid climate changes. Lacking rain and snow, a dry and warm summer climate.

Based on average climatic values recorded over a period of 30 years, the average annual temperature is approximately 19.1°C.

Field activities were carried out on 2-hectare subplots, where various soil tillage methods were applied.

Three soil tillage variants were tested in the experiment, each repeated three times, resulting in a total of six subplots. Each plot was 27 m wide and 240 m long, with a total area of approximately 650 m²

Soil tillage methods

The predecessor of winter wheat is winter rape. After harvesting the rape, harrowing was carried out, two weeks before sowing, plowing was carried out, and on the day of sowing, plowing was carried out before sowing with the Compactor. The AVENUE variety was sown on September 30 with a seeding rate of 3.0 million/ha with the SUP 29 seeder. The width between rows – 12.5 cm. Before sowing, the seeds were treated with Kinto Duo, 2.5 l/t (prochloraz, 60 g/l + triticonazole, 20 g/l) and Cruiser, 0.5 l/t (thiamethoxam, 350 g/l).

AVENUE wheat variety

A non-arrested, early wheat variety, recommended for cultivation in all crop areas, but especially in the southern and southeastern areas of Romania due to the fact that it reaches flowering (not maturity) before the arrival of very high temperatures

Very good production potential, having a high twinning capacity

Medium-sized plants, with very good tolerance to falling

It has very good tolerance to wintering, and good tolerance to brown rust and fusarium wilt

Recommended sowing density: 370-400 b.g./m2.

MMB 36-40 g,

MH: 80 kg/hl

The study compared three distinct tillage strategies applied to the experimental plot. These methods were: Conventional tillage with residue incorporation (TAV): Applied to the area adjacent to the main 6-hectare plot. Light tillage with a heavy disc harrow (LDG): A method involving a more superficial intervention. Light tillage with a rotary tiller (LDR): An intensive method of fine-crushing the surface layer. Each of these treatments was replicated three times to ensure the statistical validity of the results. The details of the tillage operations applied specifically to the AVENUE winter wheat crop are summarized in a separate section (Table 2, according to the original reference).

Determination of Initial Soil Parameters Before calculating the qualitative work and energy indices, it was essential to accurately characterize the initial conditions. The following key soil properties were determined: Resistance to penetration (degree of compaction). Degree of soil fragmentation. Soil moisture. Soil moisture values, essential for understanding the water regime, were recorded at three test points, at a depth of 30 cm, corresponding to the maximum working depth (full details can be found in Table 1). Compaction Assessment (Penetration Resistance)A penetrometer was used to determine the level of soil compaction. It was equipped with a rod to which a standardized penetration cone was attached by screwing, having:Base area: 1cm^2,top angle: 60^0 Measurements were collected and stored digitally using a "data logger" mounted on the device.The measurements were carried out at a depth of 30 cm, at an average moisture content of 12.36%.

The distribution of the cone penetration resistance forces in the soil layers, in kPa measured at 6 test points, is shown in Table 2.

Table 1. Measured soil moisture values

Measuring depth, cm	Humidity value, %
10	12.50
20	12.80
30	11.80
Average	**12.36**

Table 2. Determined values for penetration resistance

Measuring depth, cm	No. test/Resistance to penetration, kPa					
	1	2	3	4	5	Mediated
10	75	95	125	115	105	103
20.0	210	350	455	350	312	335
30.0	512	650	680	775	665	656

The soil resistance to penetration is classified according to the I.C.P.A. methodology, medium class (260-500) kPa.

The seed drill used, model SUP 29, was set for a seed rate of 250 kg per hectare. This setting corresponded to position C-18 on the gearbox (Northon gearbox). The distance between the rows (inter-row spacing) was set at 12.5 cm. To check the accuracy of the operation, a seeding test was carried out. The seed count on an area of 1 m^2 indicated a density of 400 to 420 seeds per m^2. Soil Friability AssessmentTo determine the degree of friability (or fineness) of the soil, the following instruments were used:Three sieves (sieves) with mesh diameters of 25 mm, 50 mm and 100 mm.A metal frame with a surface area of 1m ^{2}.A scale-type dynamometer for determining masses (weights).3. Presentation of Results . The resulting grain size fractions, specific to each experimental batch, are detailed in Table 3.

RESULTS AND DISCUSSIONS

Crop Establishment

According to the initial settings, the SUP 29 seeder was adjusted for a seeding rate of 250 kg/ha, using the C-18 position of the Northon box, with a distance of 12.5 cm between rows. The sowing test confirmed a seed density of between 400 and 420 seeds/ m^2.

Figure 1. Disc harrow with heavy discs 16-18 cm (2 time)

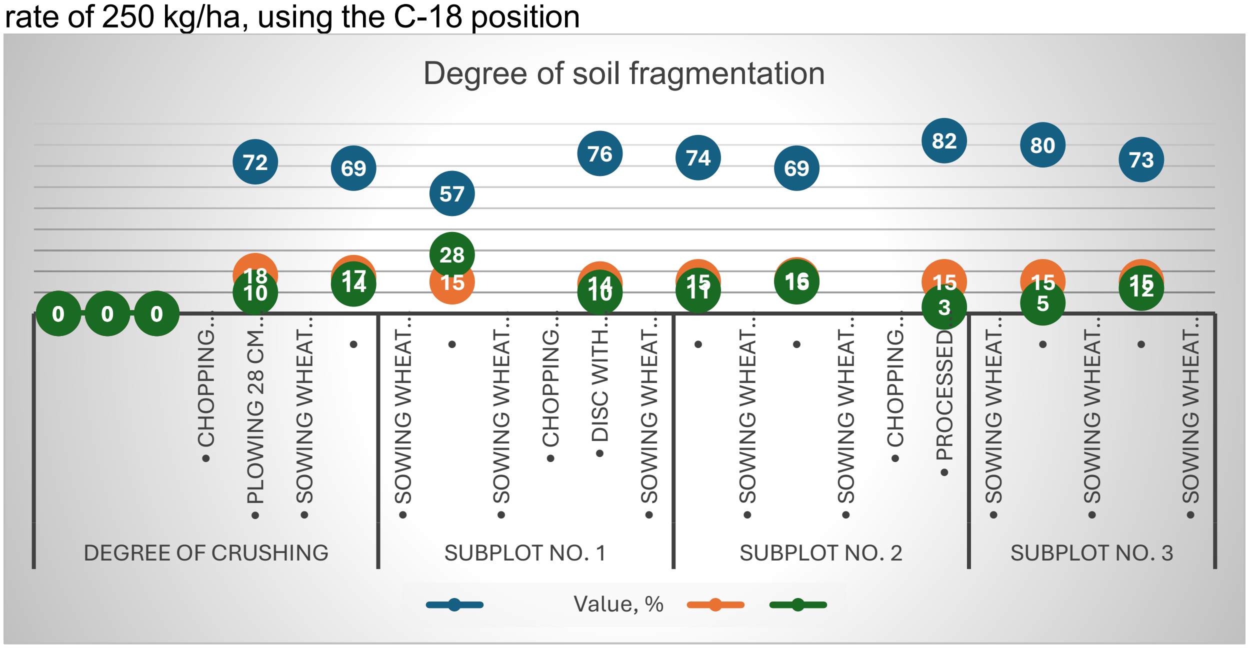

Table 3 Degree of soil fragmentation

Degree of crushing	Agricultural work	Value, %		
		Fractions below 25 mm	Fractions between 25-50 mm	Fractions over 50 mm
Subplot no. 1	• Chopping vegetable waste • Plowing 28 cm + harrowing • Sowing wheat to a depth of 3 cm	72	18	10
	• • Sowing wheat to a depth of 5 cm	69	17	14
	• • Sowing wheat to a depth of 7 cm	57	15	28
Subplot no. 2	• Chopping vegetable waste • Disc with heavy disc harrow 16-18 cm (2 times) • Sowing wheat to a depth of 3 cm	76	14	10
	• • Sowing wheat to a depth of 5 cm	74	15	11
	• • Sowing wheat to a depth of 7 cm	69	16	15
Subplot no. 3	• Chopping vegetable waste • Processed soil with a rotary harrow 16-18 cm • Sowing wheat to a depth of 3 cm	82	15	3
	• • Sowing wheat to a depth of 5 cm	80	15	5
	• • Sowing wheat to a depth of 7 cm	73	15	12

Figure 2. Chopping of vegetable waste.
Ploughing 28 cm + harrowing.

Figure 3. Soil worked with a 16-18 cm rotary harrow

Determination of the degree of emergence

It was done by counting the plants grown on an area of 1 m^2 ,

Figure 4 Plants to sprout after 10 days

Table 4. Statistical-mathematical analysis of the degree of seed germination

No	Groups	Frequencies	Relative frequencies	Cumulative absolute frequencies	Cumulative relative frequencies
1	59-66	2	0.17	2	0.17
2	67-74	3	0.25	5	0.42
3	75-82	1	0.08	6	0.50
4	83-90	2	0.17	8	0.67
5	91-98	4	0.33	12	1.00
6	92 - 98	3	0.25	5	0.42
	Total	15			

Statistical analysis of wheat germination

The interpretation of statistical-mathematical data, carried out by grouping by frequency intervals, highlighted the distribution of the percentage of seed germination.

The highest percentage of cases (33% of the total seeds sown) recorded a germination rate in the range of 92% - 98%. The analysis of the cumulative absolute frequencies indicates that 8% of the seeds reached a germination rate of up to 82%.According to the cumulative relative frequencies, this threshold of 82% (or below) represents 50% of the total seeds analyzed.In addition, 25% of the total seeds germinated in a range between 67% and 74% (full details can be found in Table 4).

A percentage of 17% of the seeds recorded a germination in the ranges of 59% - 66% and, respectively, 83% - 90%.It is confirmed that the degree of germination is directly influenced by the agrotechnical works carried out in order to properly prepare the germination bed.

CONCLUSIONS

This research aimed to analyze the impact of three distinct soil tillage methods on wheat emergence and germination.

Soil is a living, constantly changing system in which physical, chemical and biological properties are constantly interacting. Any external action, such as tillage, influences this complex dynamic.

Through its physical manipulation, not only the physical structure of the soil is altered, but the chemical and biological characteristics of the soil environment are also indirectly affected.

The experimental results indicated that most of the physical properties of the soil were negatively affected by conventional tillage methods (which most likely involved the three plowing operations mentioned above).

Significant differences were recorded between the effects generated by the three tillage strategies tested.

In general, the best performance in terms of emergence rate of wheat crop was obtained by the method using the rotary tiller (LDR).

On the other hand, the method involving the heavy disc harrow (LDG) led to a decrease in the emergence rate and even to a reduced uniformity of it.

The effects of tillage techniques are not uniform, but vary considerably, being strongly conditioned by climatic, regional and environmental factors.

It is essential that these parameters are carefully evaluated before implementing any tillage method. Neglecting these aspects can lead to compromising the germination and emergence process of crops.

In the context of this study, it is considered that the unfavorable climatic conditions of that year (namely moisture deficit and low temperature) constituted an additional factor that exacerbated the decrease in the observed emergence rate..

Recommendation: Given the superior performance recorded, it is suggested that the germinal bed preparation method with rotary tiller (GSR) be adopted in cultivation practices.

REFERENCES

Guş, P., Rusu, T., Ileana B. (2003). *Sisteme convenționale şi neconvenționale de lucrare a solului.* Cluj Napoca RO:Editura Risoprint,

DeLaune P.B., Sij J.W.,(2012) - *Impact of tillage on runoff in long term no-till wheat systems.* Soil. Tillage Kladivko, E.J. (2001) *Tillage systems and soil ecology.* Germany, Soil & Tillage Research

Kisic I. et al., (2017)*The influence of Tillage and Crops on particle size distribution of water-eroded soil sediment on stagnosol SRW,* Soil and Water Research,

A. Tolon-Becerra (2012)*Effects of different tillage regimes on soil compaction, maize (Zea mays L.) seedling emergence and yields in the eastern* Argentinean Pampas region

Van den Putte A. et al, (2010)*Assessing the effect of soil tillage on crop growth a meta-regression analysis on European crop yields under conservation agriculture,* ELSEVIER Soil and Tillage Research

***https://www.finantariagricole.ro/sfat/pregatireapatului- germinativ/, acces. 28.11.2018 [137]

***https://www.icpa.ro/documente/coduri/Cum_poat e_fi_lucrat_solul.pdf, acces.