Bulletin of University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca. Agriculture
Open Access

Research of the Influence of Agrophytotehnical Works on Rapeseed Production Parameters

Vasile-Adrian HORGA, Vlăduț-Ionuț ȘTER, Dan-Laurențiu SUCIU, Ionuț-Bogdan HULUJAN*, Teodora FLORIAN, Alexandru-Daniel COSTIN, Teodor RUSU

Faculty of Agriculture, University of Agricultural Sciences and Veterinary Medicine of Cluj-Napoca, Calea Mănăștur, Street No 4-5., Cluj-Napoca, Cluj, 400001, Romania
** Corresponding author: I.B. Hulujan e-mail: ionut-bogdan.hulujan@usamvcluj.ro*

RESEARCH ARTICLE

Abstract

Two tillage systems were studied between 2022 and 2023 in Grebenișu de Câmpie and near Ungheni city (Mureș County, Romania) and their impact at growth and production parameters of rapeseed crop. Also, for each tillage system, the growth plant parameters have been monitorized. One of the studied tillage systems was conventional, including stubble cultivation followed by ploughing at 25 cm depth. The second tillage system was minimum tillage, using a trailed field cultivator for soil preparation, at a depth of 20-25 cm, one day before seeding. In both tillage systems, power harrow was used before seeding. During the growth stages of rapeseed, the plants were analyzed and compared for each tillage system and for each field from Ungheni area and from Grebenișu de Câmpie. The morphological characters were analyzed in laboratory. All colected data were statistycal represented in tables by location and by tillage system. In the variant with conventional plough, average height, number of branches, stem thickness and root development were smaller than in the fileds with minimum tillage. Regarding the morphological characters of plants, a significant difference was determined in the height and the number of plant branches, the values were higher at minimum tillage system.

Keywords: agrotehnics; growth; rapeseed; tillage.

Received: 02 October 2023
Accepted: 31 October 2023
Published: 15 November 2023

DOI:
10.15835/buasvmcn-ag:2023.0015

INTRODUCTION

Rapeseed occupies a particularly place in the world economy, as a source of vegetable oils (Metspalu et al., 2015). Rapeseed oil has wide food uses, being able to be used directly in food or be used to obtain other products. Oilseed rape is the third most important source of vegetable oil (Beckman, 2005) used both in humans nutrition and animal feeding, and for biofuel as well produces at least two times more oil per hectare than soybean (Durrett et al., 2008). Agricultural systems that minimize environmental damage as well as the use of non-renewable resources are imperative for sustaining global food production capacity (Gotosa et al. 2021). Tillage as well as soil fertility management practices impact the physical, chemical and biological properties and processes of soil resources and thereby affect their sustainable use and productivity (Alam et al. 2014). All tillage systems can be used in rapeseed crop (Axinte et al., 2006) and minimum tillage may result in yields close to those obtained after ploughing, with lower costs (Soane et al., 2012) and environmental benefits in long term. Conservation tillage practices including no-till and minimum till, by contrast, have been shown to positively impact soil structure and stability in agricultural systems (Nunes et al., 2020). In the last century, the disadvantages of soil inversion have become more evident (Gruber et al., 2011) but, with few exceptions, less is known about the

advantages of minimum and conservation tillage under Central and Eastern Europe climate.

Agricultural practices, in particular tillage and traffic of machinery, add an extra variation, affecting the movement of water and nutrients, the carbon and nitrogen balance, and the root growth of plants (Strudley et al. 2008). According to Strudley, conventional tillage (CT) represents the most intensive tillage treatment (Strudley et al. 2008). On the other hand, tillage can reduce infiltration by reducing soil aggregate stability and microporosity, increasing surface crusting, and causing soil consolidation after tillage in the absence of crop residues on the soil surface (Unger, 1992).

Other effects deriving from tillage and machinery passage include hardpan formations and superficial sealing, preferential water flow, and structure alterations (Hillel 2004; Chan et al. 2006; Pathak et al. 2011; Etana et al. 2013; Sasal et al. 2017). This is the reason why crop rotations optimize not only the usage of nutrients and decrease disease incidences but also the root systems over time leading to a better soil structure and a decreasing spatial variability within the soil (Chan et al. 2006). Only periods following moldboard plow operations seem to significantly influence solute flow because tillage induces macropore network destruction, increase of water retention, and disturbance of earthworm activity (Gupta et al., 1991, Ahuja et al., 1998, Blouin et al., 2013).

MATERIALS AND METHODS

The studies were carried out in the period 2022-2023 in the pedoclimatic conditions of Mureş County. Two tillage systems were used:

- conventional tillage
- reduced tillage

During April-October, four rapeseed plots were studied with two different tillage systems, in Grebenişu de Câmpie commune and near Ungheni. The hybrid used was DK Expansion, a hybrid bred by Dekalb.

Two rapeseed fields were located in Grebenişu de Câmpie, a commune with average annual air temperature about 9 °C and average annual precipitation about 650-700 mm. The soil type is a molic preluvisol with 6,5 pH value. The geographical coordinates are as follows: 46°36′46″N 24°17′31″E. One field included stubble cultivation followed by conventionally plough at about 25 cm depth and the other one included a Tiger trailed field cultivator for soil preparation, at a depth of 20-25 cm, one day before seeding. In both fields, the power harrow has been used for seedbed preparation. The sowing date was 27 August 2022.

The farm "SC Ceragrim SRL" was founded in the 1994 year and its main activity is crop production and livestock farming. The farm is located in Ungheni city-Mureş County, with average annual air temperature about 8,7 °C and average annual precipitation about 650 mm. The soil type is a cambic chernozem with 7,2 pH value.

The geographical coordinates are: 46°29′9″N 24°27′39″E**.** Near the farm, two fields were cultivated with rapeseed but tillage system applied was also different. For one field, plough was used at about 25 cm depth. The other field included same Tiger cultivator used in Grebenişu de Câmpie, at about 20-25 cm depth. Also, in both tillage systems, power harrow was used. The sowing date was 29 august 2022.

The area of the analyzed lots was about 100 m^2 for each rapeseed plot from Grebenişu de Câmpie and near Ungheni-Mureş County (Romania). A set of analyses were established for each plot with its tillage system. In these fields, rapeseed plants were analyzed during their growth stages.

The parameters monitored for each plant were: root development, average plant height, plant stem thickness and number of branches per plant. In each plot were established 5 control points, in the main diagonal of the field.

The results were calculated in laboratory and statistical represented using R program, Student T-test method.

In conventional tillage a Fendt Vario 933 was used and a Kuhn plough (Figure 1. a). In reduced tillage, with the same tractor, a Horsch Tiger cultivator was used (Figure 1. b).

(a)

(b)

Figure 1. a) Fendt Vario 933 and Kuhn plough, b) Horsch Tiger cultivator

In the laboratory, a couple of observations were made for each location and tillage system. Root development (Figure 2. a) and plant stem thickness (Figure 2. b) were analyzed and compared with a large printed ruler. The observations were written in a table.

(a) (b)

Figure 2. a) Root development, b) Plant stem thickness

Also, for each location and tillage system, plants have been analyzed for branches per plant (Figure 3. a) and for plant height. All rapeseed plants were taken at the physiological maturity. For plant height measurement, a tape measure has been used from the top of the plant, to base. The observations were written in a table.

(a) (b)

Figure 3. Plant observation a) Plant branches b) Plant height

RESULTS AND DISCUSSIONS

The statistically results were structured in tables and separates by areas (Grebenişu de Câmpie and Ungheni) and by used tillage systems. For each table, the differences by the morphological characters of plants were mentioned.

Regarding the height, the number of branches and the length of the root of the plants from the conventional work system, the highest values were recorded in the Ungheni area.

The highest value of the stem thickness was recorded in the plants from Grebenişu de Câmpie area.

Regarding the morphological characters of plants, no significant difference was determined between the two areas (Table 1).

Table 1. The morphological characters in the conventional system from 2 zones

Variables	Grebenişu de Câmpie n=5	Ungheni n=5	p-value
Plant height (cm)	152.00±5.34	153.60±14.64	0.891
Branches number	9.40±1.14	9.80±3.96	0.837
Stem thickness (cm)	1.46±0.15	1.36±0.21	0.409
Root lenght (cm)	11.92±3.00	12.14±3.86	0.922

Regarding the height of the plants in the minimum tillage work system, the highest values were recorded in the Grebenişu de Câmpie area. The highest number of branches, the value of the thickness of the plant stem and the length of the root in the minimum till system was recorded for the plants from Ungheni.

Regarding the morphological characters of plants, no significant difference was determined between the areas (Table 2).

Table 2. The morphological characters in the minimum tillage system from 2 zones

Variables	Grebenişu de Câmpie n=5	Ungheni n=5	p-value
Plant height (cm)	163.80±10.03	163.40±15.66	0.963
Branches number	11.00±2.35	13.20±3.90	0.311
Stem thickness (cm)	1.60±0.45	1.62±0.41	0.943
Root lenght (cm)	12.12±1.39	14.90±3.18	0.111

Regarding the height, the number of branches, the thickness of the stem and the length of the root of the plants in the Grebenişu de Câmpie area, the highest values were recorded for the plants from the minimum tillage work system.

Regarding the morphological characters of plants, a significant difference was determined in the height of the plants depending on the work systems ($p<0.05$, Student t-test), (Table 3).

Table 3. The morphological characters of the plants in Grebenişu de Câmpie area

Variables	Conventional n=5	Minimum till n=5	p-value
Plant height (cm)	152.00±5.34	163.80±10.03	0.049
Branches number	9.00±0.71	11.00±2.35	0.105
Stem thickness (cm)	1.46±0.15	1.60±0.45	0.531
Root length (cm)	11.92±3.00	12.12±1.39	0.896

Regarding the height, the number of branches, the thickness of the stem and the length of the root of the plants from the Ungheni area, the highest values were recorded for the plants from the minimum tillage work system.

Regarding the morphological characters of plants, no significant difference was determined between the work systems (Table 4).

Table 4 The morphological characters of the plants in Ungheni area

Variables	Conventional n=5	Minimum till n=5	p-value
Plant height (cm)	153.60±14.64	163.40±15.66	0.337
Branches number	9.80±3.58	13.20±3.90	0.209
Stem thickness (cm)	1.36±0.21	1.62±0.41	0.240
Root length (cm)	12.14±3.86	14.90±3.18	0.252

Regarding the height, the number of branches, the thickness of the stem and the length of the root of the plants in general, the highest values were recorded for the plants from the minimum tillage work system. Regarding the morphological characters of plants, a significant difference was determined in the height of the plants and the number of branches depending on the work systems ($p<0.05$, Student t-test), (Table 5).

Table 5 Morphological characters of plants

Variables	Conventional n=5	Minimum till n=5	p-value
Plant height (cm)	152.80±10.42	163.60±12.40	0.049
Branches number	9.40±2.45	12.10±3.25	0.043
Stem thickness (cm)	1.41±0.18	1.61±0.41	0.180
Root length (cm)	12.03±3.26	13.51±2.74	0.286

The impact for soil physical proprieties and plants growth depends by chosen tillage system.

Excessive use of mechanical tilling can lead to soil degradation, including negative effects on bulk density, soil slope, aggregate stability, water holding capacity, infiltration rates, as well as organic matter and biological activities (Álvaro-Fuentes et al. 2013).

CONCLUSIONS

Following the research carried out during the years 2022-2023 in two locations (Grebenişu de Câmpie and near Ungheni city- Mureş County) the two tillage systems used, influence morphological characters of plants.

Analysis shown that minimum tillage, with a heavy cultivator is more efficient for plant growth and development than conventional tillage with classic plough, especially for plant height and branches number.

After the harvest of the fields, the production per ha was about 4500 kg in conventional tillage (plough), and in the field with reduced tillage (cultivator) the production per ha was about 4850 kg.

Author Contributions: V.A.H., D.L.S. and A.D.C. Conceived and designed the analysis; V.I.Ş. Collected the data; I.B.H and T.F. Performed the analysis; V.A.H and T.R. Wrote the paper.

Funding Source: The authors received no specific funding for this work.

Acknowledgments

UASVM Cluj-Napoca financed participation in the symposium and the publication of the article.

Conflicts of Interest

The authors declare that they do not have any conflict of interest.

REFERENCES

1. Ahuja LR, Fiedler F, Dunn GH, Benjamin JG, Garrison A. Changes in soil water retention curves due to tillage and natural reconsolidation. Soil Science Society of America Journal. 1998 Sep;62(5):1228-33.
2. Alam MK, Islam MM, Salahin N, Hasanuzzaman M. Effect of tillage practices on soil properties and crop productivity in wheat-mungbean-rice cropping system under subtropical climatic conditions. The Scientific World Journal. 2014 Jan 1;2014.
3. Álvaro-Fuentes J, Morell FJ, Madejón E, Lampurlanés J, Arrúe JL, Cantero-Martínez C. Soil biochemical properties in a semiarid Mediterranean agroecosystem as affected by long-term tillage and N fertilization. Soil and Tillage Research. 2013 May 1;129:69-74.
4. Axinte M, Roman GV, Borcean I, Muntean LS. Fitotehnie. Editura Ion Ionescu de la Brad; 2006.
5. Beckman C. Vegetable oils: Competition in a changing market. Agric. Agri-Food Can. 2005;18(11).
6. Blouin M, Hodson ME, Delgado EA, Baker G, Brussaard L, Butt KR, Dai J, Dendooven L, Pérès G, Tondoh JE, Cluzeau D. A review of earthworm impact on soil function and ecosystem services. European Journal of Soil Science. 2013 Apr;64(2):161-82.
7. Chan KY, Oates A, Swan AD, Hayes RC, Dear BS, Peoples MB. Agronomic consequences of tractor wheel compaction on a clay soil. Soil and Tillage Research. 2006 Aug 1;89(1):13-21.
8. Durrett TP, Benning C, Ohlrogge J. Plant triacylglycerols as feedstocks for the production of biofuels. The Plant Journal. 2008 May;54(4):593-607.
9. Etana A, Larsbo M, Keller T, Arvidsson J, Schjønning P, Forkman J, Jarvis N. Persistent subsoil compaction and its effects on preferential flow patterns in a loamy till soil. Geoderma. 2013 Jan 1;192:430-6.
10. Gotosa J, Kodzwa J, Gwenzi W, Nyamangara J. Maize nitrogen uptake and productivity under reduced and conventional tillage. Nutrient Cycling in Agroecosystems. 2021 Jan;119:23-36.
11. Gruber S, Möhring J, Claupein W. On the way towards conservation tillage-soil moisture and mineral nitrogen in a long-term field experiment in Germany. Soil and Tillage Research. 2011 Oct 1;115:80-7.
12. Gupta SC, Lowery B, Moncrief JF, Larson WE. Modeling tillage effects on soil physical properties. Soil and Tillage Research. 1991 Jun 1;20(2-4):293-318
13. Hillel D. Introduction to environmental soil physic. Elserier Science, San Diego, California. 2004.
14. Metspalu L, Veromann E, Kaasik R, Kovacs G, Williams IH, Mänd M. Comparison of sampling methods for estimating the abundance of Meligethes aeneus on oilseed crops. International journal of pest management. 2015 Oct 2;61(4):312-9.
15. Nunes MR, Karlen DL, Veum KS, Moorman TB, Cambardella CA. Biological soil health indicators respond to tillage intensity: A US meta-analysis. Geoderma. 2020 Jun 15;369:114335.
16. Pathak P, Wani SP, Sudi RR. Long-term effects of management systems on crop yield and soil physical properties of semi-arid tropics of Vertisols. Agricultural Sciences. 2011 Nov 17;2(04):435.
17. Sasal MC, Boizard H, Andriulo AE, Wilson MG, Léonard J. Platy structure development under no-tillage in the northern humid Pampas of Argentina and its impact on runoff. Soil and Tillage Research. 2017 Nov 1;173:33-41.
18. Soane BD, Ball BC, Arvidsson J, Basch G, Moreno F, Roger-Estrade J. No-till in northern, western and south-western Europe: A review of problems and opportunities for crop production and the environment. Soil and Tillage Research. 2012 Jan 1;118:66-87.
19. Strudley MW, Green TR, Ascough II JC. Tillage effects on soil hydraulic properties in space and time: State of the science. Soil and Tillage Research. 2008 Apr 1;99(1):4-8.
20. Unger PW. Infiltration of simulated rainfall: tillage system and crop residue effects. Soil Science Society of America Journal. 1992 Jan;56(1):283-9.