THE AGROCHEMICAL CHARACTERISTICS OF THE SOIL DETERMINED BY DIFFERENT TYPES OF WORKS

Nicoleta MĂRIN[1], Elena PARTAL[2], Mihaela ȘERBAN[2], Alexandra LEONTE[3]

[1]National Research and Development Institute for Soil Science, Agro-chemistry and Environment – ICPA Bucharest, 61 Marasti blvd, District 1, Bucharest, Romania
[2]National Agriculture Research Development Institute Fundulea, Calarasi Country, Romania
[3]Agricultural Research Station Secuieni, 617415 Secuieni, Neamţ County, Romania

e-mail*: ela_partal@yahoo.com

Abstract

The paper presents the results obtained from an experiment with different tillage systems carried out in the period 2001-2021 on the Cambic Chernozem from Fundulea. The data reflect the influence of tillage on maize yields in 2020 and 2021, two very different years from a climatic point of view (2020 – very dry, while 2021 – a medium year). In the dry year, the highest yield (3828 kg/ha) was obtained in the plots worked with the chisel which ensured a better accumulation of water in the soil, and the lowest yield was obtained in the control plots. In 2021, the highest yield (7510 kg/ha) was obtained in the variants ploughed in autumn, and the lowest in the control plots (2036 kg/ha). In both years, spring ploughing provided distinct and very significant increases in production, but much lower than fall ploughing or chiseling. The agrochemical analyzes revealed the highest values for humus, total nitrogen, available phosphorus and potassium contents, total cationic exchange capacity in the control plots, and the lowest values of these parameters in the autumn ploughed plots. The disking and spring ploughing ensured close values, but better for tillage with disks. Spring ploughing is not recommended, as it stimulates the loss of soil water and, by increasing soil aeration influences the humus decomposition. Therefore, it is recommended that spring ploughing should be replaced by tillage with disk.

The short experimenting duration at Secuieni and the high soil resilience didn't allow highlighting statistically significant soil pH, humus, total nitrogen, mobile phosphorus and potassium contents changes under the influence of different soil working methods (ploughing at 20 and 30 cm, ploughing at 30 + 10 cm, chisel work at 20 cm, and discing at 12-15 cm, and combinations between them).

Key words: *soil, tillage systems, long-term experiences, Cambic Chernozem*

INTRODUCTION

Soil resources sustainable management must rely on the older counsel that we should ”leave the agricultural land for the next generations in a better shape than we received it” and must rest upon the concept of ”use, improve, rebuild” the efficient soil capability, namely its vital functions (Lal and Stewart, 1992).

The continuous agriculture enhancement through chemistry (generalized use of insecticides and antifungals, herbicides, chalking, organic, mineral, and organic and mineral fertilizers, etc.), irrigation (spray, drip, on furrows), mechanization (soil works, harvesting, etc.) has more and stronger negative effects on soil physical, chemical, and biological characteristics and its functions.

The negative effects show through: soil abasement, biodiversity abatement, greenhouse emissions, surface and ground waters eutrophication and contamination (Dumitru et al., 2005).

Conservative agriculture is regarded as a holistic concept resting on all the technological system components: from works to vegetal resources, crop rotation, protective crops, fertilization, irrigation, pest control, harvest, and transport complex management (Marinca et al., 2009) and is often regarded as a solution for reducing greenhouse emissions and soil carbon preservation.

Conservative agriculture excludes conventional soil working through furrow-turning ploughing, demands that soil surface be covered (at least 30%) with live vegetal layer or vegetal mulch
(vegetal leftovers from the previous crop), demands long-term cropping systems including amelioration crops.

Acording to Canarache and Dumitru (2008), low tillage systems can be applied on 42% of the arable land of the Country, namely 15% in favorable (with no restrictions) and 27% in moderately favorable (with some restrictions) conditions. Low tillage systems specific to plane land can be applied on 27% of the arable land and 15% - to slope land.

Soil works are the basic component of any agricultural model including the conservative technological systems. This triggered the National Agriculture Research Development Institute (NRDIA) Fundulea to organize a long term experiment with soil works (no works, chiseled, ploughed in the autumn, ploughed in the spring, and discing) in which yield level and some agrochemical soil indicators are monitored, while the Agricultural Development Research Station (ADRS) Secuieni initiated an experiment with diverse soil works combinations consisting of ploughing down to 20 and 30 cm, plowing down to 30 + 10 cm, chiseling at 20 cm, discing at 12-15 cm, monitoring soil works influence upon yield and some agrochemical soil characteristics.

The soil generally remains compressed after harvest, due to its own weight action and that of the machines and used agricultural tools, or rainfall drops and/or irrigations (Petcu, 1998). So, soil works in order to achieve an optimum ratio between capillary and non-capillary porosity and a plant as much as possible favorable water, air, and nutrition condition are mandatory.

Different soil works forms led to soil profile bedding into the ploughed layer by alternating light and compact strata (Dumitru et al., 1999).

MATERIAL AND METHOD

The research investigated the influence of different soil works types upon yield and soil chemical characteristics in two long term experimental fields, at NRDIA Fundulea from 2001 to 2021, and at SCDA Secuieni, from 1986 to 2018.

The long term (2001-2021) experiment placed at NRDIA Fundulea on a Cambic Chernozem included five types of soil works: not worked, chiseled, ploughed in the autumn, ploughed in the spring, and discing. Uniform fertilization was applied each four years with N120P150. The experiments were organized in tandomized blocks design with four replicates. Data were computed using analysis of variance (ANOVA) and graphics were drawn in Excel.

Soil works effect upon some soil chemical characteristics (pH, humus content, total nitrogen, mobile phosphorus and potassium) was studied at ADRS Secuieni, on a Cambic Phaeoziom, in an 2014-1018 experiment, in a three years crop rotation (maize – soy – wheat). The fertilization system was N60P60 for maize. It was assessed that no potassium fertilizers were needed during the experiments period as the soil was very well supplied with this element and yield gains would have been low and not statistically ensured.

Soil was sampled on the 0-20 cm depth according to ICPA Methodology.

Soil chemical analyses were performed using the following methods:

- pH determination in aqueous suspension 1:2.5; SR 7184-13:2001;
- humus determination: wet oxidation; STAS 7184/21-82;
- total nitrogen (Nt) determination: Kjeldahl method; STAS 7184/2-85;
- mobile phosphorus (P_{AL}) determination: extraction in ammonium acetate lactate solution at pH 3.7 and colorimetric determination; STAS 7184/19-82;
- mobile potassium (K_{AL}) determination: extraction in ammonium acetate lactate solution at pH 3.7 and flame

photometry determination; STAS 7184/18-80;

- electric conductivity determination and total soluble salts appraisal (conductometric residue); STAS 7184/7-87 cap. 3.2;
- cationic exchange properties: sum of bases (SB); STAS 7184/12-88;
- cationic exchange properties: hydrolytic acidity (Ah); STAS7184/12-88.

RESULTS AND DISCUSSIONS

Soil works can influence plants vegetation conditions by number, execution time, and combiner types achieving:

- A favorable environment for cultivated plants growth and development;
- Normal activity for microorganisms;
- Weeds control;
- Pest control;
- Fertilizers, chalking, pesticides, and vegetal remains incorporation.

a) The experiment at NRDIA Fundulea unfolded in the 2001-2021 period. The data presented in this paper regard the 202-2021 period because it was assessed that soil chemical characteristics statistically significant modifications can only be obtained after long time.

Researches carried out over 20 years on the Fundulea Cambic Chernozem showed that the highest maize yield in droughty years are obtained by soil loosening with the chisel (Figure 1). Ploughing comes second and discing third. The lowest yields were obtained in both experimental years in the variants not worked (Figure 2).

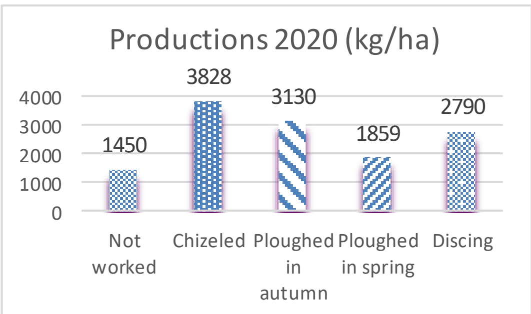
Ploughing in the spring offered higher yields than the variants not worked in both years, but lower than all the other variants because it stimulates water loss from soil before seeding. Maize yield was 1,859 kg/ha in the 2020 droughty year and 3,803 kg/ha in the normal 2021.

When ploughing is done in the autumn it is preferable to prepare the land in spring by discing.

Țopa and Jităreanu (2018) assessed that repeated use of disc harrows contributes to soil structure destruction and its dusting so their use must be careful and even limited.

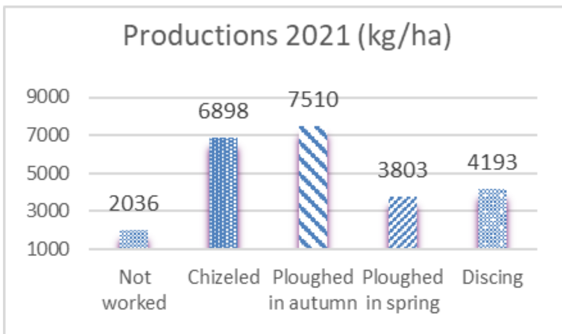
In the years with normal rainfall deep ploughing ensures the highest maize yields (7,510 kg/ha), chiseling comes second (6,898 kg/ha). Discing led to average yields between the variants not worked and the spring ploughing and behind autumn ploughing and chiseling.

Petcu (1998) showed that performing basic works after maize favored water reserves accumulation in soils bigger in the variants ploughed at 30 cm, ploughed at 20 cm, and worked with soil loosening tools without furrow-turning as compared to the variants worked with the disc harrow and seeding directly in the land not worked.



Dl 5% = 212
Dl 1% = 309
Dl 0.1%= 464

Figure 1. Maize yield obtained in 2020



Dl 5%= 133
Dl 1%= 194
Dl 0.1%= 292

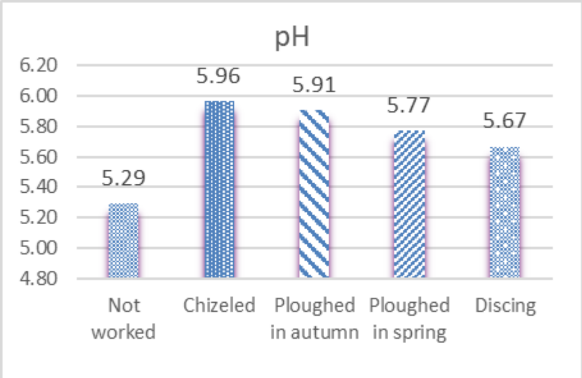
Figure 2. Maize yield obtained in 2021

Data from 2021 presented in Figure 3 show that the lowest pH values were registered in the variant not worked, followed by discing, ploughed in spring, ploughed in autumn, and chiseling. In no-till systems organic and mineral fertilizers application on the surface and vegetal remains decomposition lead to rapid soil acidification in the first 2-5 cm. Differences can be of one unit at 5-15 cm (Marinca et al., 2009). Minimum or no-till system accelerates organic matter oxidation by soil microorganisms through aeration, temperature, and nutrition environment (Burtan et al. 2016).

The highest soil humus content was noticed in the variants not worked in the discing ones, in which soil pH was higher, and the lowest in the variants ploughed 30 cm deep. Similar results were obtained by Țopa et al. (2013) on the Ezăreni Farm, Iași, Cambic Chernozem.

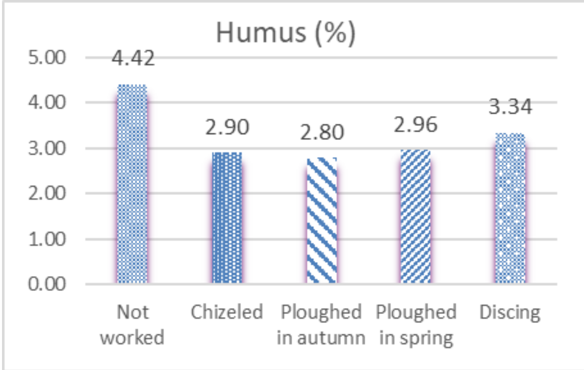
In the parcels worked by chisel a similar humus content is noticed with the one of the parcels ploughed in spring.

In all the worked variants humus level is very significantly lower than in those not worked. When increasing the soil working depth and using furrow-turning yield increases and humus level is reduced if adequate organic and mineral fertilization is not ensured.



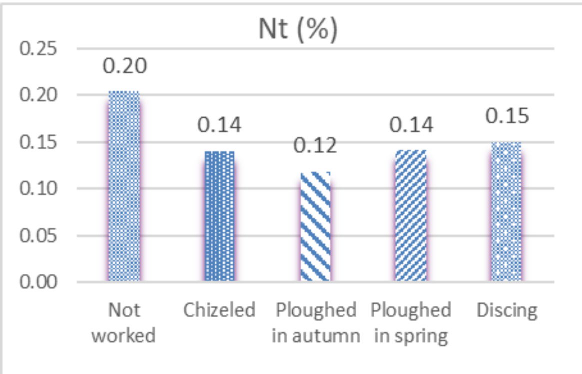
Dl 5%= 0.29
Dl 1%= 0.42
Dl 0.1%= 0.63

Figure 3. Soil works influence upon pH



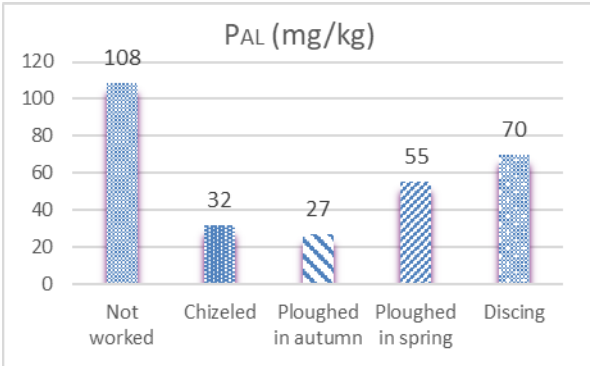
Dl 5%= 0.15
Dl 1%= 0.22
Dl 0.1%= 0.33

Figure 4. Soil works influence upon humus content



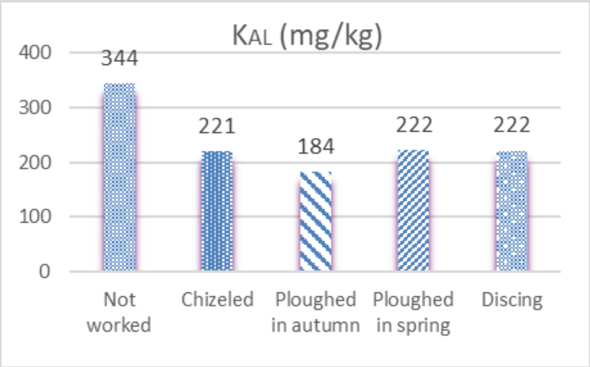
Dl 5%= 0.02
Dl 1%= 0.02
Dl 0.1%= 0.03

Figure 5. Soil works influence upon soil total nitrogen



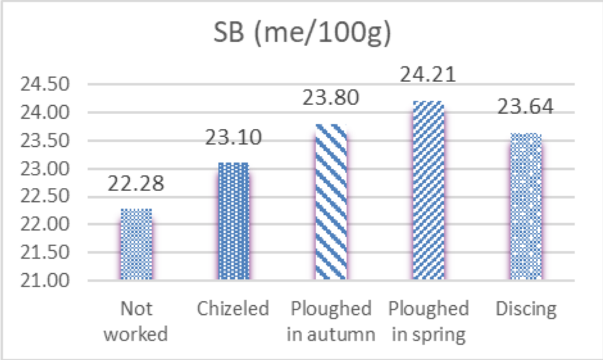
Dl 5%= 27
Dl 1%= 40
Dl 0.1%= 60

Figure 6. Soil works influence upon mobile phosphorus



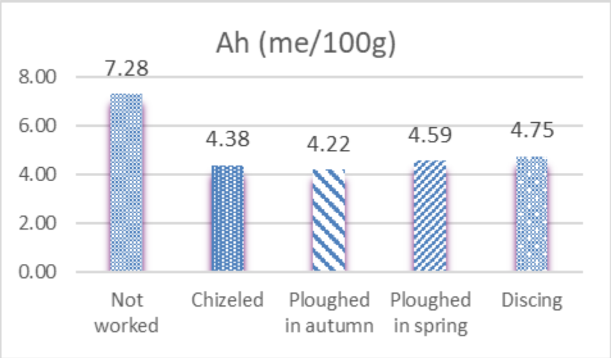
Dl 5%= 55
Dl 1%= 81
Dl 0.1%= 121

Figure 7. Soil works influence upon mobile potassium



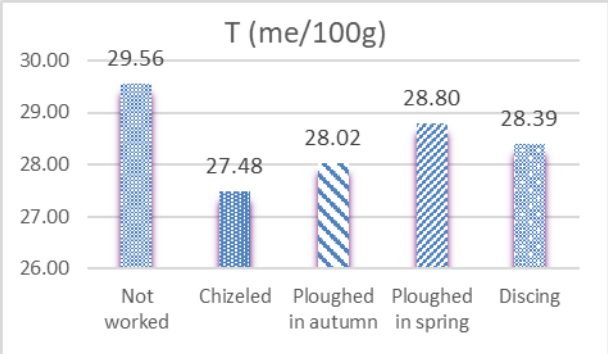
Dl 5%= 0.66
Dl 1%= 0.96
Dl 0.1%= 1.44

Figure 8. Soil works influence upon the sum of bases



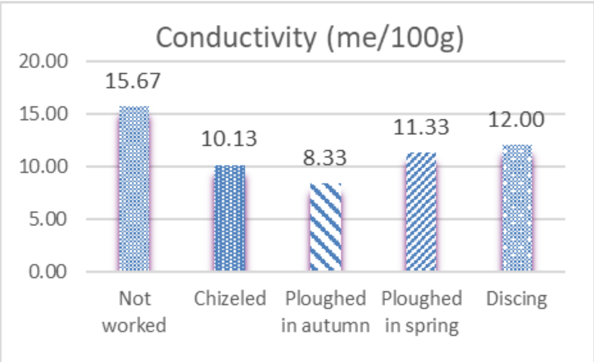
Dl 5%= 0.45
Dl 1%= 0.65
Dl 0.1%= 0.98

Figure 9. Soil works influence upon hydrolytic acidity



Dl 5%= 0.72
Dl 1%= 1.05
Dl 0.1%= 1.58

Figure 10. Soil works influence upon total cationic exchange capacity



Dl 5%= 2.84
Dl 1%= 4.14
Dl 0.1%= 6.22

Figure 11. Soil works influence upon electric Conductivity

The data presented in Figure 5 regarding total nitrogen level evolution following different soil works systems application highlight a similar behavior with the soil humus. The highest values were obtained in the parcels not worked and the lowest following autumn ploughing application 30 cm deep. The values of the chiseled parcels and of those ploughed in spring were similar. Soil preparation with disk led to a lower decrease of the soil nitrogen, but not statistically significant. The nitrogen evolution proved to be similar to that of the humus.

The positive effects of the low soil loosening technology are attributed to working intensity and frequency decrease, vegetal remains quantity increase on the soil surface, higher organic matter content accumulated in soil, biodiversity stimulation, lower costs and energy usage (Calciu et al., 2010).

Because 60 kg/ha phosphorus fertilization was only applied once in four years it was not sufficient for cultivated plants. Yield increase led to mobile phosphorus soil level abatement. The highest mobile phosphorus levels (figure 6) were noticed in the variants not worked and the lowest in the variants ploughed 30 cm deep in the autumn. Soil working with the disk led to significant mobile phosphorus decreases and spring ploughing to distinctly significant ones. Very significant decreases were brought about by chisel works and deep ploughing.

Soil phosphorus content changes in direct relation to the technological processes taking place during each agricultural work. Thus, on the 0-10 cm depth, on land worked by chisel, paraplow, and disc harrow, phosphorus content increases by accumulation in the upper horizon. When working with the plow phosphorus content registers a slight decrease following more efficient use by plants and better distribution in the ploughed soil (Guș et al., 1998).

The highest mobile potassium values were noticed in the variants not worked and the lowest in the variants ploughed in autumn (Figure 7). All the systems presented very significantly lower soil mobile potassium values as compared to the variants not worked and the values of works with disk, chisel, and spring ploughing were equal.

The sum of exchangeable bases (figure 8) significantly increased as compared to the variant not worked and the highest values were in the variants ploughed in autumn.

Hydrolytic acidity values (Figure 9) are the highest in the parcels not worked and the lowest in the variants ploughed in autumn and worked with chisel.

The total cationic exchange capacity values (Figure 10) are the highest in the parcels not worked, where humus values are also higher, because cationic exchange capacity is directly correltated with humus content. The lowest values are in the variants worked with chisel.

The highest conductometric residue values (Figure 11) are in the parcels not worked and the lowest, very significantly lower as compared to those not worked, in the variants ploughed in autumn. Distinctly significantly lower values as compared to the control without works were registered in the variants worked by chisel or ploughed in spring. The lowest values, significantly lower than the control without works, were registered in the variants worked by disks.

An increase of bulk density was noticed at wheat and maize crops on the Fundulea Cambic Chernozem when replacing ploughing with discing. The most favorable bulk density values were determined by ploughing at 30 cm, then chiseling, and the highest values were brought about by discing (Ioniță, 1997).

After seven years of experimentation on the Fundulea Cambic Chernozem total soil porosity decreased in the 0-40 cm layer when ploughing was replaced with superficial working with the disc harrow two years in a row. The lowest total porosity values were registered in the 10-40 cm layer on land only worked by disc harrow.

Soil loosening works by tiller plow 20 and 30 cm deep contributed to reduce the weed infestation degree in wheat and sun flower crops by 35-50% as compared to working with the disc harrow and the seeding in not worked land method.

The least weed infestation of the land was registered in the variant ploughed 30 cm deep in autumn (Petcu, 1998).

b) Results of the research of the ADRS Secuieni experimental field

The yields obtained were influenced by the soil working method (tools, depths, works alternation) and also by the climatic conditions registered in the research time.

The ADRS Secuieni experimental field was set up in 2014 and soil samples were taken after 5 experimentation years.

The highest maize yields were registered in the variant ploughed 30 cm deep and the lowest in the discing variants 12-15 cm deep. Ploughing at 20 cm and 30 + 10 cm didn't significantly influence yields level. Chisel works caused very significant yield losses. The longer the time of disc or chisel working the lower the yield (Lupu et al., 2017).

Due to the short experimenting time and the high soil resilience degree the applied soil works didn't result in statistically significant changes of pH values and soil humus, total nitrogen, and mobile phosphorus and potassium contents.

Resilience is one of the most important and complex soil characteristics; it is in fact a soil attribute that implies its ability to react as an ”elastic body” when it is subject to a force, or a pressure, or an action and to come back to its initial form or position when the actions cease. So, the soil has the capacity to restore its vital processes that have been affected by certain human activities if these were not drastic and if the action time was short or if the time passed after the action was long enough. Resilience is related to that properties entirety which determines is buffering capacity against the respective physical, chemical, or biological impact.

CONCLUSIONS

- Soil works with soil loosening tools chisel-type (without furrow-turning) favored large water quantity retention in soil in droughty years;
- Spring ploughing must be avoided and can be replaced by discing;
- Autumn ploughing ensures the highest yields but also the highest nutrition elements and fuel usage, and offers better conditions for organic matter decomposition and greenhouse gas emissions increase;
- The lowest maize yields and the highest humus, nitrogen, phosphorus, and potassium reserves were obtained in the parcels not worked;
- Applying different soil working methods or associations of methods on the ADRS Secuieni Cambic Faeoziom didn’t lead to statistically significant changes of pH values, and soil humus, total nitrogen, and mobile phosphorus and potassium contents due to the short experimentation time and high soil resilience.

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