INFLUENCE OF MINIMUM TILLAGE ON HUMUS AND MINERAL NUTRIENTS CONTENT

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Abstract. *Unconventional soil cultivation and its different variants used in some Romanian farms are preferred due to their cultivation technology and economic advantages, as well as to their compatibility with the Common Agricultural Policy. The option for unconventional systems depends on the system of agricultural machines and on the physical soil features, particularly clay content and compaction degree. Unconventional systems need knowledge of technological crop requirements as well as of the way fertilisation can be adapted and weeds can be controlled. Unconventional systems influence both soil features and energy inputs. Benefits of applying unconventional systems are:Soil cultivation time is reduced 2-4 times; Fuel consumption per area unit is reduced with 30-50%;The number of agricultural machines per area unit is reduced;Soil structure and surface and depth soil compaction are recovered; Organic matter in the soil increases;Water permeability in the soil increases and global soil drainage improves;Soil erosion is reduced;Plant debris on soil surface or incorporated in the soil (10-15 cm deep, where biological activity is maximum) contribute to soil flora and fauna growth;Ground and surface water quality is maintained (nutrients and pesticides are no longer washed away by erosion and more intense biological activity – associated to soil organic matter – uses and decomposes the nutrients);Air quality is maintained by reducing fossil fuel emissions (Diesel) used in the field and by reducing the carbon released in the atmosphere (it is fixed by soil organic matter increase). Humus content in the soil tends to increase with minimum soil tillage. This is partly due to larger amounts of plant debris (minimum 30%) at different decomposition stages when left on soil surface and in the first 10-20 cm and, on the other hand, to the balance between mineralisation and humidification achieved by specific physical, thermal, and biological regimes. Measuring humus content after 4 years shows an increasing trend of up to 0.41%. The values reached 3.11% in the ploughed variant and 3.12-3.52% in the minimum tillage variants.*

Keywords: *conservative works, agricultural machines and equipment, humus content, mineral nutrients*

INTRODUCTION

Currently, conservative works define extremely varied processes. There are, between the classical/conventional agricultural system (tillage, preparation of germinative bed, sowing) and the conservative agricultural system (no tillage) – where intervention on the soil is minimal – numerous methods of soil cultivation specific to certain cultivation conditions, equipment's, and even traditions. It is well known that agriculture contributes to global warming with about 1/3 of greenhouse gases released into the atmosphere mainly on soils affected by erosion and compaction. Soils cultivated after ploughing release into the atmosphere larger amounts of carbonic gas than no-tillage ones. This is just one aspect of our option for a protective agricultural system.

MATERIAL AND METHOD

Influence of minimum soil cultivation systems on humus and mineral nutrients content

Soil cultivation is done with different agricultural machines and equipment to prepare the most favourable environment for plant growth and development.

Soil cultivation is important because:

It aerates, minces, or compacts soil to achieve a favourable ratio between capillary and non-capillary gaps, thus improving soil water, air and temperature regimes;

It controls weeds and destroys pest sources (diseases and pests);

It incorporates in the soil organic debris (stubble, weeds) that are decomposed producing humus and nutrients;

It intensifies soil biological and chemical processes, microorganism activity, and nitrogen fixing bacteria activity.

Mobile phosphorus and potassium in the soil changes significantly under the impact of the soil cultivation system, i.e., fertilisers are placed at different depths. Thus, rotary harrow work places large amounts of mobile phosphorus in the first 10 cm of soil and paraplough and chisel do the same, but the phosphorus is in practically equal amounts 10-20 cm deep in the soil. Aeration intensity and higher plant density motivate smaller amounts of mobile phosphorus when ploughed with classical plough.

Humus content in the soil tends to increase with minimum soil tillage. This is partly due to larger amounts of plant debris (minimum 30%) at different decomposition stages when left on soil surface and in the first 10-20 cm and, on the other hand, to the balance between mineralisation and humidification achieved by specific physical, thermal, and biological regimes. Measuring humus content after 4 years shows an increasing trend of up to 0.41%. The values reached 3.11% in the ploughed variant and 3.12-3.52% in the minimum tillage variants.

Table 1

Influence of the soil cultivation method on humus and mineral nutrients content (0-20 cm)

Feature variant	Final 2017				
	Initial (2013)	Classical plough + disc 2x	Paraplough rotary harrow	Chisel + Rotary harrow	Rotary harrow
Humus, %	3.02	2.84	2.93	3.12	3.15
Mobile P ppm/100g soil	130	108	125	135	142
Mobile K ppm /100 g soil	165	170	165	182	183
N total, %					
0-10 cm	0.210	0.214	0.236	0.246	0.236
10-20 cm	0.230	0.254	0.214	0.236	0.256
20-30 cm	0.252	0.263	0.211	0.214	0.196

Currently, conservative (unconventional) soil cultivation covers extremely varied procedures from direct sowing (no-tillage, direct drill) to deep aeration with no furrow turning. Between these two extremes there are also reduced cultivation (classically rationalised), minimum tillage (covering below 30%), mulch tillage (coverage above 30%), ridge tillage, strip till or zone till), cover crops or catch crops), etc. This terminology points out the specific character defining the procedure at a certain point in time, in any area, in accordance with local specificity.

From the perspective of the development of sustainable agriculture, it is unanimously accepted that there is no universal soil cultivation system because of local differences and of the technical level of endowment.

Soil conservation systems in different areas should have specific features depending on the local ecological features and on the crop cultivation technology features, which makes differentiation compulsory.

Minimum soil cultivation systems – paraplough, chisel, or rotary harrow – are polyvalent alternatives for basic cultivation, preparation of germinative bed, and sowing on lands with moderate aeration requirements they are also optimised technologies of rationalisation and activation of soil natural fertility, erosion reduction, water holding capacity increase, and sowing at optimal time opportunity.

The influence of the cultivation system on soil features is an important indicator of soil fertility conservation and of the sustainability of the agricultural system.

Soil fertility conservation supposes applying a cultivation system that optimise crop cultural requirements with soil changes ensuring the improvement of soil features as well as high, constant yields. Soil fertility conservation is, thus, indissolubly bound to maintaining and improving soil fertility indicators as well as to the productivity of the cultivation system.

The option for unconventional systems depends on the existence of an agricultural machine system and on soil physical features, particularly clay content and soil compaction.
Unconventional cultivation systems suppose knowing crop technological requirements and how to adapt fertilisation and weed control.

Influence of minimum soil cultivation systems on fuel consumption

One of the technological operations with high Diesel consumption is furrow turning ploughing, particularly on medium-fine or fine texture soils and with deeper ploughing. Replacing this type of ploughing or, at least, replacing it partially and ploughed only after 2-3 years, particularly when yields do not diminish substantially, are a solution to reduce fuel consumption.

RESULTS AND DISCUSSION

Mechanical soil cultivation through traditional methods is increasingly questioned nowadays because of the high fuel consumption and of arable land degradation through erosion and excessive compaction. It is unanimously known that the current soil cultivation system has seriously damaged the environment and its vital resources – soil (by decreasing its fertility) – despite its considerable contribution to social progress.

The shortcomings of the classical (conventional) soil cultivation system – an intensive system including mouldboard plough – have brought about the concept of soil conservation through unconventional soil cultivation systems, i.e., periodically or completely giving up mouldboard plough, rationalising the number of cultivations, and preserving on soil surface at least 15-30% of plant debris. This system is applied on about 45% pf arable land worldwide and it is estimated that it will reach 60% in the 20 years to follow. It is also known as “Soil Conservation Cultivation System”.

CONCLUSIONS

Minimal soil cultivation systems are alternatives to the conventional soil cultivation system, that conserve soil features and ensure yields.

Using for 4 years consecutively the same soil cultivation system with crop rotation – maize, soy, wheat – determined an improvement of soil physical, hydro-physical, and biological features, soil structure recovery, and soil water permeability increase.

Yields after using minimal soil cultivation systems show that result can be different and that choosing the cultivation variant depending on the crop is decisive.

The conclusion of measurements regarding soil penetration resilience is that in all variants of conventional and unconventional soil cultivation systems soil penetration by the roots is not hindered.

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