ABSTRACT

This doctorate thesis: THE INFLUENCE OF DIFFERENT TILLAGE SYSTEMS OVER THE PHYSICAL, CHEMICAL AND BIOLOGICAL QUALITIES OF THE SOIL AND THE YIELD OF PRINCIPAL CROPS was done on 4 years field, laboratory and office research.

Modern agriculture, intensive, with high yield, exercises big solicitation over the soil and an insufficient knowledge of the way how soil reacts to this sort of solicitations can have negative consequences, manifested by degradation processes, destroying even their yield capacity (Canarache A. et al., 1978, 1990, Hamza M.A. et al., 2005, Garcia – Orens F. et al., 2005). At the elaboration of certain tillage system must have in view the soil conditions, plant and climate which can influence or be influenced by that system (Frensluelbers A.S., 2002). Benefic effects of the tillage system over a culture must maintain the other factors at on acceptable level, and this way the increase of the yield, the decrease of the fuel consumption or the increase of the production capacity of the soil must be possible by solution of economical optimization (Zenter R.P., 2004, Gzy Ewa, 2004). Tillage system besides to the direct effects, benefic for the culture technology of the plants, induce in soil also remanent effects for a long period of time, which next over the physical and physical – mechanical properties of the soil, modifying it (Canarache A., 1978, 1986, Necheff V., 1995, Pintilie C. et al., 1979, Dich R.P., 1992, Dexter A.R., 2004 Chimicholm L.S. et al., colab. 2005).

Physical properties of the soil have a great influence over the way in which the soil functions in an ecosystem. The growth and development of the plants, the hydric regime and the soil solution is in corelation with its physical properties (Hamza M.A. et al., 2005, Dexter A.R., 2004). Physical properties of the soil give also indications for the tillage system that can be used and against erosion (Pangliai M., 2004). Through different technical ways this quality can be ameliorated in a way which they can assure optimal conditions for the plant growing. Aerations and temperature regime is modified itself in accordance with the tillage system the modification of the physical quality its hard to notice excepting soil compactation in cause of an agricultural year because the soil tends in normal conditions to come back at the initial stage and to estompate the negative effects of the tillage system (Guş P., et al., 1998, Osunbitan S.A. et al., 2005, Lagston S. et al., 2005). Many researches show that in long time the evolution of the physical qualities in a certain direction is slow, after a shorter period when the values short to stabilize (Fabrizzi K.P. et al., 2005, Ferreras L.A. et al., 2000, Reynolds W.D. et al., 2002). Almost entirety, physical qualities are conditioned by texture and structure. Together the structure and the soil texture helps to determine the storage capacity with nutrients of the soil solid phase and the capacity of the soil to retain drive the water and air necessary to the radicular activity of

the plants (Scot D.I. et al., 2005, Chen Y., 2005). In modern thinking structure is one of the main characters with direct and indirect influence over all the physical, mechanical and biological processes that toke place in the soil (Canarache A., 1990, Dexter A.R., 1998, 2004, Cannaly R.D., 1998). A lots of the obtained research data indicat a strong correlation between soil structure and plant growth.

Microorganisms have great influence on the soil structural aggregates building, especially by the sensitized organic substances which favored aggregation of the mineral particles (Six S. and Oades F.M., 1993). The formation of structural stable aggregates depends on the microbial activity and on the number of microorganisms (DeGryze et al., 2005). Tillage system has a big and complex influence over structures. The influence of the tillage system on the soil structure stability is evidenced in the research publications. The obtained research data shows that structural hydrostability depend on the chemical and physical soil properties and clime conditions.

Actual preoccupations for the adaptation of sustainable agricultural systems are justified by the extension in warning proportions of the degradation and deterioration of the soil resources. The maintenance or introduction of new technological systems must be in concordance with durable progress principles, to ensure the possibility of progress and development.

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The main objectives of these Ph. D. theses are:

- establishment of the influence of different crop system on some physical, chemical and biological soil properties;

- the effect of the agricultural machine traffic on the modifications of soil properties;

- the dynamic of hydrophysical soil properties in the vegetation period;

- to establish the influence of crop system on the chemical soil properties;

- the distribution on soil profile of the fertilizing macroelements;

- the analyze of the influence of tillage system and fertilization on the microorganisms from the soil;

- the analyze of the influence of soil tillage and fertilization on the corn, wheat and bean yield in the Moldova Plateau conditions.

- the energetical efficiency of different soil tillage and fertilization systems.

The experiments have been conducted in the Didactic Station of the USAMV – Iasi, Ezăreni Farm, during the period between 2002-2005, on a cambic chernozem with 3,4 % humus and 7 pH value. The treatments were arranged in a split-plot design and replicated three times. Tillage treatments

were plough to 20 cm, plough to 30 cm, working with chisel and working with disc harrow and two different fertilizations levels applied to three crops species (been/ wheat/ maize rotation).

It has been taken soil samples at sowing period, in different growing stages and at harvesting in order to determinate the water content, soil structural aggregates distribution, structure hydrostability, bulk density, penetration resistance, total water capacity, soil aeration, soil total porosity, etc. Based on the primary data, it have been calculated wilting point, field capacity, available moisture holding capacity, aeration porosity, inactive and utile porosity, compactation degree, indices of soil structure quality, etc. In the same time we determined the soil humus content, phosphorus and mobile potassium, soil organic carbon, total nitrogen, the soil reactions, It has been estimated the rate of saturation in bases, C/N rate, nitrogen indices, humus reserve, etc.

In order to evidence the dynamic of the soil microorganisms, at different depth and growing stages for every crop, were taken some soil samples. The prelevated soil samples have been examined at microscop for the control of their purity and as well to evidence the bacterial cells morphology. Concomitantly it have been studied the distribution of the microorganisms in arable layer.

Also it has been determinate the yield and the elements of productivity. Statistical analyze of obtained data was also calculated using the variance analysis and trend lines. Energetic efficiency was calculated with the basic energetic indicators like energetical balance sheet, energetical efficiency, etc.

Researches carried out on chambic chernozem in the Didactical Station Ezareni used the influence of tillage systems on the physical and hydrophysical properties of the soil revealed different aspects. Wilting point, available moisture holding capacity and field capacity variation it has been reduced and the values of this coefficient are lower with the increase of soil depth and growing stages, no matter what kind of tillage system it has been used. The values of these indices have been bigger with the increasing of soil mobilization. Bulk density has increased from sowing to harvesting in all variants of tillage system and all layers.

In all the research period the variation of compactation degree was insignificant. The values of this parameter slowly increase from sowing to harvesting in all tillage systems variant. Penetration resistance values also increase from sowing to harvesting in all tillage systems. The values of the total porosity decrease from sowing to harvesting in all tillage systems variant. The values of the bulk density decrease from sowing to harvesting, in and in all tillage systems. Aeration porosity becomes smaller at the same time with depth increasing, in all vegetation stages, in all soil tillage system. Utile porosity was not significant influenced by depth, growing stages or tillage systems. In the same time with increase of the bulk density values, the aeration porosity decreased and a fraction of pores that were holding the water used by plants reduced their dimensions, in this way the inactive porosity increased.

The proportion of structural aggregates with diameter > 5 mm increased during plants growth and on the depth. Hydrostability of the soil aggregates has been increased from sowing to harvesting and from superficial layer to the deeper layers of soil, the highest values has been found in the conventional tillage variants.

The best quality of structure was observed in the cizel variant. The structural aggregates from plough variants have higher water stability than other variants. The indices of soil structure quality increase from sowing to harvesting in all tillage systems and with the depth increasing an exception being found in disc harrow variant.

Soil tillage contributed at the modification of the air and water regime and the increase of the redox potential which correlated with the acidity produced by chemical fertilizers. The soil pH values decrease 0,4-0,5 units in 4 years. The biggest amplitude of pH variation was registered at variants worked without furrow turn. The low values of pH in the superficial layer are correlated with the acidity produced by the chemical fertilization applied and unincorporated in the soil and as well because of the less favorable conditions for infiltration of nitrogen and anions in the soil.

The soil's content of total nitrogen, phosphorus and mobile potassium change significantly under the influence of soil tillage systems in the way that the administered fertilizer are located at different depths. Tillage without furrow turn locates large quantities of fertilizer elements in the superior soil layers but the same thing it was observed in variants working with furrow turn.

The C/N ratio remains practically unchanged. Higher values of nitrogen indices were determined in the superficial layer (0-10 cm) in all variants, excepting the variant worked with disc harrow. It hasn't been noticed big differences between variants; average values being approximate the same.

The analyze of medium values of the rate of saturation in bases on 0-30 cm layer showed higher values of indicator in conventional variants in comparison with unconventional variants.

The content in soil organic carbon decreased in the same time with the increase of the soil mobilization and as well on depth increasing in correlation with the decrease of the soil biological activity.

The soil's content of humus has been influenced by tillage systems. On 0-20 cm depth it has been observed a tendency to growth in unconventional variants. The increasing of organic matter and is due to the vegetal remainders partially incorporated and to an adequate biological activity. Humus reserve on 0-30 cm stratum was more reduced in ploughed variants, being known the fact that the mobilization more intense of the soil favorites a quicker exhausting of the humus accumulated in time.

The physical state of the soil has a tremendous importance for the proper development of the majority of microorganisms. The microorganisms number increase progressively, whit a maximum

values at the depth of tillage. No matter what tillage system we have used, for the studied samples the morphological analysis of the strains has pointed out small qualitative differences. Important differences have been observed between crops in correlations with each stage of growing.

Tillage system and level of fertilizer determined difference between wheat, maize or been crop production, usually being bigger in conventional variants but not always significant statistically.

Correlation coefficients and trend lines between yields and the bulk density values or penetration resistances has been a negative tendency because in generally the yield decreased in the same time with the increase of compactation degree of the soil. The values of *"r"* coefficient showed that significant established correlations between yield and penetrations resistance and insignificant correlations between yield and bulk density. The increase of penetrations resistances determined a restriction for roots systems growth and a reduction of absorbing water capacity and of the nutritive substances.

There are positive correlations between crops yield and the utile. In the same time the yield increase with increasing of pores volumes which hold the useful water for plants, but the correlation coefficient has not a statistic importance.

Energetic results were greatly influenced by methods of tillage management and level of fertilization. In all crops it has been observed that the energetic expense increasing in the same time with increasing of soil mobilization and fertilization doses. The increase of nitrogen doses determinate bigger energetic expense than plow depth, this being showed by high values of indirect active energy. The energy produced was superior with every system which means the more intense mobilization of the soil and the quantity of fertilization increase.

Energetic balance sheet and coefficient of efficiency had bigger values in the plowing variants than in the variants worked without furrow turn but the indices progressed contrarily with fertilizer doses used.

The obtained results confirm the literature data, but they are specific for experimental conditions in Moldova Plateau and contribute with new elements for a better understanding of the phenomenon.