THE IMPACT OF MODERN TECHNOLOGIES APPLIED TO MAIZE CROP ON THE FERTILITY OF THE REDDISH PRELUVOSOIL

Key words: soil tillage, maize production, soil fertility, maize, chemical fertilizers with nitrogen and phosphour, manure, soil chemical analysis (apparent density, total porosity, capillary porosity, uncapillary porosity, capillary capacity, infiltation speed), chemical analysis at soil (pH, total carbon, extractable carbon, soil hydrolytic acidity, the degree of base saturation, total exchange cationic capacity, C/N ratio), biological analysis (soil respiration, cellulosoliytical activity) and enzimic analysis (cathalase, phosphatase and amidase), speciphicals indices**.**

SUMMARY

Demographic pressure in parallel with technical progress in time generated an intensivization of agricultural production by promoting some elements such as genetically advanced plant breeds and hybrids, chemical fertilizers with macro and micronutrients, irrigation, plant protection products and new machinery that increased labour productivity, which led to a continuous growth in crop yields. The only element that has degraded in time is the soil, the actual basis of agricultural production, whose organic matter content decreased in the last 85 years by 0.5-0.7%, in some zonal soils in Romania having reached an alarming drop of 2.2-2.5%.

This situation has been caused by the lack of due consideration to the mechanisms of soil biology and by instead applying agressive techniques that disregard the role of organic matter. Maize, the crop plant we target in this paper, holds the third place in the world with over 109 million of ha cultivated and the first place in Romania, and the issues related to soil fertility are more critical because of the more intense soil tillage that accelerates the mineralization of organic matter in soil.

The aim of this paper is to determine, in a peas – wheat – maize rotation, the influence of primary soil tillage and direct sowing used in conjunction with organic and/or mineral fertilization to compensate for soil mineralization on the main physical, chemical and biological indicators of soil fertility. We consider that by finding alternative solutions to the current tillage system applied on the reddish preluvosoil and the other soil types in Romania could lead to a sustainable agriculture system designed to increase the organic matter content in soils.

The main goal of this doctoral thesis was to study the impact of modern technologies applied to maize crop on the fertility of the reddish preluvosoil. This research aims to analyse the changes in soil physical properties under primary soil tillage and then mineral and organic fertilization on the 0-30 cm depth.

Sectorial objectives targeted the physical, chemical and biological components of soil fertility and the analysis of the influence of soil tillage and organic and/or mineral fertilization on maize yield in the peas-wheat-maize rotation in the 2012-2014 experimental period.

Research method. The 8x8 experience was placed in the field according to the method of subdivided parcels, where the A factor is represented by soil tillage and the B factor is the fertilization, in

5 repetitions.

The A factor – soil tillage had the following variants for maize crop: a_1-ploughing at 15 cm, a_2-ploughing at 20 cm, a_3-ploughing la 25 cm, a_4-chiseling at 20 cm, a_5-chiseling at 30 cm, a_6-disc ploughing at 10 cm, a_7-direct sowing and a_8-ploughing at 20 cm + GV 1,5.

The B factor – fertilization had the following variants for maize crop: b_1- unfertilized, b_2 - 10 t/ha manure, b_3 - 5 t/ha wheat straws +N_{50}, b_4 - $N_{100}P_{70}$, b_5 - $N_{50}P_{70}$, b_6 - $N_{150}P_{70}$, b_7 - P_{70}, b_8 - N_{50}.

The soil tillage and plant protection systems applied in this case except for the studied factors corresponded to those characteristic to the area.

The yield data as well as those resulting from the analyses carried out were statistically processed through the method of variance analysis with two influence factors. For the findings corresponding to soil biology and chemistry the variants were divided in value groups according to the Tukey procedure (Snedecor 1968).

Findings. Over the vegetation years, the diversity of climate conditions ranging from drought in 2011/2012 to very favorable in 2012/2013 enabled a thorough analysis to determine the influence of soil tillage and fertilization as well as soil fertility components on yield.

The influence of soil tillage and fertilization on the obtained yields. The influence of soil tillage and fertilization on yields obtained in 2012. The gathered data show that, generally, under severe drought in the vegetation period, except for the direct sowing and the ploughing at 20 cm + GV 1,5 which led to certain yield decreases, among soil ploughing at 15 cm, 20 cm and 25 cm or chiseling at 20 cm or 30 cm there were no major yield differences unless when combining the application of manure with chiseling at 30 cm and when combining the application of $N_{100}P_{70}$ when ploughing at 20 cm. The experimental data showed that the organic fertilization with 10 t/ha manure prevails over the mineral fertilization with $N_{100}P_{70}$. To be exact, the highest yield in the whole experiment was of 41,32 q/ha and was recorded at the fertilization with $N_{100}P_{70}$ when ploughing at 20 cm followed by the amount of 36,84 q/ha recorded at the fertilization with 10 t/ha manure when chiseling at 30 cm.

The influence of soil tillage and fertilization on the yields obtained in 2013.

The highest yield in the experiment was of 85,73 q/ha, recorded when combining the application of $N_{100}P_{70}$ with chiseling at 30 cm. The reason for the highest yields having been recorded after having tilled the soil at 20-30 cm is that plants benefited from better physical conditions offered by the soil loosening and at the same time the chemical fertilization increased the biological activity.One year after having been applied, the Blackjak product didn't make substantial changes – except for the variants of chiseling at 20 cm and ploughing at 20 cm + GV 1,5 where it resulted in yield decreases – in the general influence of soil tillage on maize yield.

The influence of soil tillage and fertilization on the yields obtained in 2014. The highest yields in the experiment, of 76,23 q/ha and 76,07 q/ha in the first value group were recorded when ploughing at 25 cm and chiseling at 30 cm respectively with significant yield boosts of 2,09 q/ha and 1,93

q/ha respectively, joined with no significant yield boost and a yield of 74,51 q/ha by the variant with ploughing at 20 cm + GV 1,5. The fertilization especially by applying nitrogen has a complementary role in nutrition by counterbalancing the increase in acidity and mineralization caused by soil tillage when turning furrows. It seems that this temporary role played by fertilization on greater depths is relatively proportional to the applied nitrogen dose undergoing mineralization as well as levigation this year.

The influence of soil tillage and fertilization on the yields obtained on the average of the 2012-2014 research years. In the variants chiseled at 20 cm the first place was held by the application of $N_{150}P_{70}$, followed by the statistically undifferentiated fertilization with 10 t/ha manure and by the statistically differentiated application of $N_{100}P_{70}$ and in the variant chiseled at 30 cm, by the application of $N_{150}P_{70}$, $N_{100}P_{70}$ and 10 t/ha manure which wasn't statisticaly differentiated.

The influence of soil tillage and fertilization on the soil fertility indicators. We carried out research on the characteristic soil tillage and fertilization variants regarding their influence on the main physical, chemical and biological indicators of soil fertility. The study of the influence of soil tillage and organic and mineral fertilization **on the main physical indicators of soil fertility** had the following findings:

Regarding the physical indicators, the values of apparent density as a synthetic element certainly decrease when chiseling at 30 cm and increase when ploughing at 25 cm regardless of the climate conditions of the experimental year.

Regarding the physical indicators, the values of apparent density as a synthetic element certainly decrease when chiseling at 30 cm and increase when ploughing at 25 cm regardless of the climate conditions of the experimental year. The direct sowing have to total porosity a very significative decreasing.

The capillary porosity values had increases at the variant chiseled at 30 cm in the arid year and at least distinctly significant values in the rainy year 2012, with lower values at the variants ploughed at 25 cm, chiseled at 20 cm, disc ploughed at 10 cm and sown directly. The variant ploughed at 25 cm had certain very significant decreases in both years.

The recorded values indicate that regardless of the soil tillage, at the soil surface, in the maximum activity area the capillary porosity is highest except for the variants fertilized with $N_{100}P_{70}$ when ploughing at 20 cm and chiseling at 20 and 30 cm.

The changes in apparent density, total porosity and capillary porosity can be explained through the dynamics of the humification-mineralization ratio depending on the intensity applied when tilling the soil, the tilling depth and the capacity to counterbalance with the fertilization method.

Concerning the apparent density show significative decreasing at chisel at 30 cm and significative increasing to plowing at 25 cm ohne correlation with climatic condition in experimental year.

Regarding the chemical indicators of soil fertility. *The pH values* decreased over a period of 10

years at a rate of 0,093 units/year when fertilizing with $N_{150}P_{70,}$ with no significant differences between soil tillage methods on the average of fertilization. The highest pH between 5,43 and 5,57 were recorded when fertilizing with 10 t/ha manure and the lowest, of 4,46-4,72 when applying $N_{150}P_{70}$. The general fertilization regime recommended so far in the area, of $N_{100}P_{70}$ led to pH values of 4,63-4,90 depending on the soil tillage system. The research carried out highlighted that the pH values were also influence by the crop plant, the highest values being recorded under maize crop.

The content in organic carbon was strongly influenced by the soil tillage system, the 25 cm ploughing determining on the average of fertilizations a decrease of 0,41%/10 years in comparison with the 30 cm chiseling, which equals to cca. 0,04%/year, which is cca. 0,05%/year without fertilization, 0,08%/year when applying 10t/ha manure, 0,022%/year when applying 5 t/ha straws + N_{50}, 0,029%/year for $N_{100}P_{70}$ and 0,021%/year for $N_{150}P_{70}$. The accumulation of organic carbon was the best for disc ploughing, the crops reaching 3,1% under peas, 2,9% under maize and 2,71% under wheat.

When studying the influence of soil tillage a distinctly significant correlation can be seen between the carbon in the humic acids and the carbon in the fulvic acids only for the soil tillage systems with furrow turning.

The highest values of *the C/N ratio*, of 12,13 were recorded when chiseling and applying 10 t/ha manure and the lowest when disc ploughing with no fertilization (8,63) and for $N_{100}P_{70.}$

The highest values of *the cation exchange capacity* were recorded when disc ploughing and fertilizing with $N_{150}P_{70.}$

When the two factors interact, it can be seen that the highest value of *hydrolitic acidity*, of 8,95 m.e./100 g soil was recorded when disc ploughing and fertilizing with $N_{150}P_{70}$, being significantly influenced by the chemical fertilization, and the lowest value was recorded when ploughing at 25 cm and not fertilizing (2,77 m.e./100 g sol).

The highest values of the base saturation degree, of cca. 77,8-80% were recorded when ploughing and applying an organic fertilization of 10 t/ha manure with slight differences depending on the soil tillage. Through the acidification effect, the application of nitrogen in time leads to the decrease of the base saturation degree by cca. 23% which equals with cca. 2,3%/year when fertilizing with $N_{150}P_{70}$.

Regarding the biological indicators of soil fertility. The highest value of *the potential respiration*, of 35,607 mg CO_2/100 g soil was recorded when disc ploughing at 10 cm alongside fertilization with $N_{150}P_{70}$. The highest *cellulosolitic activity*, of 14,28 mg biodegraded cellulose was recorded when chiseling at 30 cm alongside fertilization with $N_{100}P_{70.}$ Out of the crops included in the rotation in the unfertilized variant, the highest cellulosolitic activity of 5,22 mg biodegraded cellulose was recorded under peas. The highest values of *catalase activity*, of 260,74 cm^3 O_2/100 g soil and 213,03 cm^3 O_2/100 g soil were recorded when applying organic fertilization with 10 t/ha manure alongside disc ploughing and applying 5

t/ha straws + N_{50} alongside ploughing at 25 cm. The most intense *phosphatase activity* in the experiment, of 5,580 mg P/100 g soil was attained in the unfertilized variant when ploughing at 15 cm, followed by the variant fertilized with $N_{100}P_{70}$ when applying the same soil tillage.

Regarding the compound indicators of soil fertility. For the variants which were organically fertilized or unfertilized, the vital activity tends to be more intense at lower tilling depths, higher values being recorded when applying 5 t/ha straws + N_{50}. The mineral fertilization that provides additional nitrogen nutrition on the whole increases to almost double the level of vital activity at lower tilling depths and when chiseling at 30 cm.

High values of the *Biological Synthetic Indicator* were recorded when tilling the soil at lower depths with the disc at 10 cm and with the plough at 15 cm alongside the application of mineral fertilization and straws. The highest value of the Biologic Synthetic Indicator, of 39,62% was attained when applying $N_{150}P_{70}$ and disc ploughing at the same time, the applied nitrogen stimulating bacterial growth.

The differentiation induced by the *Chemical Synthetic Indicator* was reduced by using 3 value groups once. When applying chemical fertilization the CSI values were lower than when applying organic fertilization. The highest value, of 60,22% was recorded when ploughing with the disc at 10 cm and applying 10 t/ha manure.

The Synthetic Indicator of Soil Fertility (ISFS%), which is the average of ISB% and ISC%, depending on the higher weighting of the Chemical Synthetic Indicator and the artificially increased values of the Biological Synthetic Indicator, highlighted that, for chemical fertilization, the highest values of 45,17%, 45,13% and 44,62% were attained when chiseling at 30 cm for $N_{100}P_{70}$, ploughing at 15 cm for $N_{100}P_{70}$ and disc ploughing at 10 cm for $N_{100}P_{70.}$ The lowest values were recorded, for all fertilization methods, when ploughing deeply at 25 cm.

Final conclusions. Although the multitude of variants and the interactions between soil tillage and organic and mineral fertilization result in a wide range of values regarding yield levels and soil fertility indicators, we are able to synthetise the following final findings:

1. The chiseling at 20 cm, specially at 30 cm are a production alternative with a increasing of soil fertility for plowing at 20 cm and 25 cm for maize.
2. Direct sowing for maize with the current machinery regardless of the fertilization system didn't have satisfactory yields.
3. The alternative for maize fertilization are the application of 10 t/ha manure or $N_{100}P_{70.}$
4. The humus low level are critical at 2% and is necessary an fertilization organic with organic residues.
5. The pH values devreased after unilateral mineral fertilization made necessary a calcium amendaments.