THE EFFECT OF SOME FERTILIZERS ON WHEAT AND CORN YIELD AND ITS QUALITY ON THE BROWN REDDISH SOIL (TYPICAL REDDISH PRELUVOSOIL) FROM OLTENIA

Fertilizers became a usual mean for Romanian agriculture. Since 1955, there have been produced and applied around 1.3 billion tones of fertilizers.

This is the fact why we consider that the decreasing of the field crops yield was due to the significant decrease, as well, of the fertilizer quantity that was applied on the field within the 1989 – 2008 period. In this respect, in 1985 there were used 1.2 million tones of fertilizers and in 2005 this quantity reached 0.46 million tones which means a 72% decreasing or, in other terms, from 129.9 kg per arable ha to 42 kg a.i. per arable hectare.

Nevertheless, it is wrong to consider that the higher the fertilizer quantity, the higher the intensity of cropping. Fertilizers bring their contribution to the yield only when they are used properly, which means proper and adapted technologies, proper doses and time of applying, splitting doses in function of the crop features, soil and clime conditions.

The fertilization system must take part of the means that the land owner has to apply in order to maintain the soil health and sustainability.

Today, more than ever, the soil fertilization has to make according with rational laws of agrochemistry, with lower inputs and economically and environmentally sound.

There results that the most important factor for a rational use of fertilizers is the maximum use of knowledge on fertilizer types that has to be applied. This problem, of fertilizer types was less studied in our country and worldwide.

This is the reason why the present doctoral thesis, „The effect of some fertilizers on wheat and corn yields and its quality on the brown reddish (typical reddish preluvosoil) from Oltenia" we were trying to bring a modest contribution to the clarifying of some aspects on the using of several fertilizer types: ammonium nitrate, urea, nitrocalcar, potassium sulfate, superfosfate and manure with the wheat and corn crops at the DRS Banu maracine – Craiova within the 2005-2008 period.

The nitrogen fertilizers: ammonium nitrate, urea and nitrocalcar have been applied at the same nitrogen active ingredient (a.i.) quantity of N_{120}, potassium sulphate of K_{100}, superphosphate at P_{72} and manure, 30 t/ha at experiment set up.

The experiment was stationary, in wheat-corn crop rotation having 12 variants in three replications as follows: V_1- unfertilized control; V_2- N_{120}

ammonium nitrate; V_3- N_{120} urea; V_4- N_{120} nitrocalcar; V_5- K_{100} potassium sulphate; V_6- 30 t/ha manure; V_7- P_{72} superphosfate; V_8- $N_{120}P_{72}$ ammonium nitrate + superphosphate; V_9- $N_{120}P_{72}$ urea + superphosphate; V_{10}- $N_{120}P_{72}$ nitrocalcar+superphosphate; V_{11}- $K_{100}P_{72}$ potassium sulphate + superphosphate; V_{12}- 30 t/ha manure + P_{72}superphosphate.

The soil

The soil where the experiment took place is a typical, reddish preluvosoil with the following profile: Ao-AB-Bt_1-Bt_2-C.

The Ao horizon: 0-29 cm; dark grey brown color (10YR3/2) in moist state; Silt-Sand texture; granular, low formed structure; fine porous; medium compact; frequent slender roots; rare earthworm feces; slow passing to the next horizon.

The AB horizon: 29-42 cm; dark brown color (7.5YR3.5/2); silty to silty-clayey texture; frequent brown-grey spots; clay films at the soil crumble surface, slow passing to the next horizon.

The Bt_1 horizon: 42-96 cm; dark brown reddish color (5YR4/4) in moist state; silty-sandy-clayey texture; prismatic structure; fine porous; compacted; very rare slender roots; evident clay films to the soil crumbles; slow passing to the next horizon.

The Bt_2 horizon: 96-161 cm; red-yellowish color (7.5YR5/6); sandy clayey silt; large structure by drying; fine porous; compacted to medium compacted; slow passing to the next horizon.

The C horizon: > 161 cm; light yellowish brown (10YR6/4); silty-sandy; not structurated; frequent medium and large sand particles; does not make effervescence.

The texture in Ao is silty sandy, in AB is Silty silty, in Bt_1 silty sandy, Bt_2 silty sandy and in C horizon is silty sandy to silty silty. The clay content varies from 18.1% to 30.7%.

The bulk density has low values in Ao (1.36 g/cm^3) and high values in AB-C (1.44 – 1.50 g/cm^3).

The aeration porosity is satisfactory in A horizon (16%) and unsatisfactory in B horizon.

The higroscopicity and wilting coefficient have reduced values in shallow horizons, of 5.84 and 8.76%.

The moisture equivalent and wilting capacity have average values 24.17% and 15-16%.

The humus content 2.56% and total nitrogen 0.131% indicate a soil with average nitrogen content.

The soil reaction is low acid (pH 6.37-6.47).

It has good phosphorus content and average potassium content (68 and 105 mg/kg) in the shallow horizon and low supplied deep ward.

Climatic conditions

Climatically, the researched zone belongs to the *cfax* – continental temperate climate.

In function of the recorded rainfall within 2005-2008 period, the researched years can be characterized as follows:

- the 2005 year was favorable both for wheat and corn crop;
- the 2006 year was very favorable for wheat crop and favorable for corn;
- the 2007 was not favorable both for wheat and corn;
- the 2007-2008 year was moderately favorable for wheat.

The biological material

With the wheat crop there was used the Dropia variety and with corn crop, Florencia hybrid.

The average results with the wheat crop

After the researches that have ben carried out within 2005-2008 period there were obtained the following results:

The plant height was directly influenced by the fertilizers, the highest increases being recorded when the nitrogen fertilizers were applied alone, of 56.68-65.52 cm, in comparison with 57.99-63.68 cm when they were applied along with phosphorus. The potassium sulphate, manure and superphosphate applied alone determine a plant growth of 3-13% higher that the not fertilized control.

The ears dimensions and the number of the grains in ear are influenced by the fertilizers, too. The highest values are obtained when the nitrogen fertilizers were applied on phosphorus background when the ears dimensions increase by 41.58 – 68.84% and the number of grains in ear by 81.3-92.7% higher than the control variant, the best results being obtained with the applying of the urea and ammonium nitrate.

The hectolitric mass was, also, directly influenced by the fertilizers; it has increased when different fertilizers types were applied alone from 70.92 kg/hl with the not fertilized control to 74.23 with the ammonium nitrate and 74.05 with the superphosphate applied alone that proves that this soil is low and average supplied by available phosphates.

The mass of a thousand grains has recorded significant changes as effect of fertilizer applying increasing especially when nitrogen fertilizers

were applied alone to values of 38.15 g with urea in comparison with the not fertilized control variant. On phosphorus background the values of the mass of a thousand grains are almost equal with the situation when nitrogen fertilizers are applied alone or slightly lower.

The wheat yield in all three experimental years was evidently influenced by different nitrogen, phosphorus and potassium fertilizers types, all types determining the increasing of the yield.

The highest yields were given by all situations when nitrogen was applied along with phosphorus: 3,703 kg/ha with nitrocalcar + P_{72}, 3,886 kg/ha with urea + P_{72}, 3,895 kg/ha ammonium nitrate + P_{72}. The potassium sulphate, manure as remnant effect and the superphosphate have contributed to the increasing of yield in comparison with the not fertilized control variant by 38-46% in comparison with the nitrogen fertilizers on superphosphate background that have increased the yield by 122-134%.

The yield outputs per kg of active ingredient of Nitrogen, P_2O_5, K_2O – the nitrogen fertilizers applied alone give an yield output of 13.84 – 15.66 kg/kg of a.i. N. The potassium sulphate give a lower output, of 7.06 kg/kg a.i. K_2O. The yield outputs obtained on kg of a.i. NP when nitrogen is applied along with phosphorus are of 11.16 to 11.61 kg/kg a.i. NP, the highest output being obtained with ammonium nitrate and urea, of 11.61 to 11.57.

The yield output given by phosphorus is between 4.88 and 5.24 kg/kg a.i. P_2O_5.

The protein quantity per hectare was highest when different nitrogen fertilizers types were applied on phosphorus background: ammonium nitrate and urea, 564.53 and respectively 544.36 kg. The potassium sulphate, superphosphate or manure, as a remnant effect have given reduced protein quantities per hectare yet by 57-79% higher than not fertilized control.

The unilateral using of the nitrogen fertilizers have conducted to the obtaining of less protein quantity/hectare, 473-492 kg/ha. All used fertilizers have increased the protein quantity per hectare by 1.6 to 3 times.

Average results with the corn crop

The average corn grain yield was between 2,196 kg/ha with the not fertilized control and 6,564 kg/ha with urea and superphosphate. High yields are obtained when nitrogen fertilizers are applied alone (5,257 – 5,427 kg/ha) yet, especially, on superphosphate background (6,247-6,568 kg/ha), the highest yield (6,568 kg/ha) was obtained when urea along superphosphate are applied.

The potassium sulphate, manure as remnant effect and the superphosphate alone determine good yields of 4,794 – 5,088 kg/ha in comparison with 2,196 kg/ha with the not fertilized control that proves the soil is low-medium supplied by potassium and the corn crop gives better results than wheat to phosphorus and potassium fertilizers.

The yield output per kg of a.i. has been of 25.51 – 32.75 kg/kg a.i. N, P_2O_5, K_2O when fertilizers are applied alone N, P and K, the highest output being recorded by superphosphate and of 15.10 – 22.77 when fertilizers were applied on superphosphate background.

The hectolitric mass of the corn grains has been higher when nitrogen fertilizers were applied alone, of 74.45 – 75.09 kg/hl in comparison with 72.09 kg/hl with the not fertilized control. The potassium sulphate, superphosphate and manure as remnant effect have had higher values of the hectolitric mass than the not fertilized control yet lower than the nitrogen variant.

The mass of a thousand grains has been directly influenced by all used fertilizers that determined evident outputs of this indicator over the not fertilized control variant. However, the highest values of this indicator have been reported with singular applying of nitrogen, 350-351 g (ammonium nitrate and urea) over 294.94 g with the not fertilized control variant.

The protein quantity per hectare has been favorable modified by the different fertilizer types. Nevertheless, the best results have been obtained with nitrogen fertilizers that determine the highest yield per hectare: 538 – 612 kg protein per hectare, on the first place is urea on superphosphate background, 612 kg/ha. The potassium sulphate and manure applied on superphosphate background conducted to lower increase of the protein quantity per hectare, between 371-407 kg.

The influence of the different fertilizer types on the main soil chemical features

Soil pH change

After four years of research, for all variants, the final pH of water soil suspension has been lower than initial value. The pH variations have been higher or lower in function of the nature of fertilizer types.

With the not fertilized control variant, the variation was -2.16. The soil became more acid with no effect of fertilizers. With all other variants the soil acidification is due to both natural conditions (as for control variant) and as a result of fertilizers. Subtracting from the total acidity the acidity of the control variant there result the soil reaction due to the fertilizers.

The following fertilizers: urea, ammonium nitrate, nitrocalcar and potassium sulphate does acidifies the soil according with the value of their physiological acidity, more urea for which the pH variation is – 6.78% and less for potassium sulphate for which the pH variation is of -0.87. With the case of these fertilizers, the soil acidification due to them is added to the one determined by the soil and clime conditions such way the pH variation resulted from experimental measurement is of -8.94% for urea and -3.03% for potassium sulphate, the soil pH decreasing by 0.61 and, respectively, 0.20 pH units.

Among the fertilizer types, only the simple superphosphate has had an alkali action, the pH variation being of only -0.62% according with its neutral physiological reaction and the dicalcic phoasphate content, a minoritary component, with basic physiological reaction.

Manure has had the most intense basic action, higher than of the simple superphosphate. The pH variation due to manure has been of + 1.54 %. The phenomenon is due to the basic ions brought by the manure and their immobilization within the soil as insoluble alkali-earthy humates, phenomenon that prevailed over the microbiological oxidation of ammonia that resulted after manure mineralization along with the setting free of protons. The soil alkalinisation due to manure was lesser than the one produced by the soil and clime conditions, such way, the final result of this process as a whole was a lesser soil acidification, of -0.62% and a very low decrease of pH by 0.04 units.

There is very probable whether the stationary manure fertilization would continue, a real alkalinisation will appear.

The binary blends of certain fertilizers produce an acidification of the soil that represents, as value, the resultant of physiological reactions of the components. The highest value variation of pH due to fertilizers has been of -2.97% for the blend of simple superphosphate and ammonium nitrate and the lowest, of -0.33% for the blend of superphosphate and potassium sulphate. The total pH variation due to both fertilizers and soil and clime conditions has been, for the above mentioned fertilizers, of -5.03% and, respectively, of -2.49%.

The influence of fertilizers on mobile phosphorus from the soil

1. In comparison with the initial distribution of the available phosphorus into the soil, between the highest and the lowest value there was a difference of 7%, after the fertilizer applying; at the end of the experiment, the distribution of the available phosphorus

into the soil has proven to be very uneven, between the highest and the lowest value of the variants, the difference being of 87%.

2. over the initial state, the phosphorus soil pool has decreased by 7-27% with variants where no phosphorus variants were applied yet it increased by 16.37% where phosphorus fertilizer was applied. The increasing and decreasing have varied in function of the fertilizer nature: with N, with P, with K, manure, NP, P+manure.
3. The phosphorus initial reserves have been high enough in order to supply even after the experiment was finished, for the variants where phosphorus content has decreased, the obtaining of high yields without supplementary available phosphorus.

The influence of fertilizers over the soil potassium

The initial uneven distribution of the soil available potash was intensified and increases at the end of the experiment. This way, whether at the beginning, between the lowest (95.08 ppm) and the highest (122.24 ppm) value of the available potassium there was a difference of 28%, at the end of the trial, between the lowest (12.03 ppm) and the highest (182.93 ppm) value of the remnant soil available potassium there was a difference of 1,420%.

Over the initial status, the soil potash pool has decreased by 30-85% with variants where no potash fertilizers were applied and they have increased to 30-70% in variants where potash fertilizers were applied.

The initial reserves of available potassium are not so high in order to supply high yields unless further potash fertilizers are applied (except V5, V6, V11 and V12).

The influence of fertilizers on total nitrogen content

Before the beginning of the experiment, the soil nitrogen total supplying degree was between 0.128 and 0.144% with a variation of 0.78 – 12.5% between variants. After the experimentation the supplying degree was between 0.128% - 0.150% with a variation of 1.01-16.77% between variants. The dispersion degree of the total nitrogen values has increased.

With variants where no nitrogen fertilizer was applied, the concentration of total nitrogen has decreased by 0.15% - 3.19% and with variants nitrogen fertilizers was applied, the concentration of total nitrogen has increased by 3% for variants fertilized with NP and 4% for variants fertilized only with N.

The soil was, initially, well supplied by humus, between 2.18-2.37%, with the variation domain of 0.5-8.7%, at the end of the trial the humus content was 2.18-2.38% with a variation between variants of 0.5-8.7% maintaining the initial degree of uniformity.