

Chemical and Microbiological Studies for Determination the Influence of Fertilizers Produced by “Agropolychim” AD on Winter Common Wheat and Oilseed Rape

Dragomir Plamenov¹, Pavlina Naskova², Bojka Malcheva³, Yordan Iliev⁴

^{1,2} Department of Plant Production, Technical University – Varna, Varna, Bulgaria

³ Department of Soil Science, University of Forestry – Sofia, Sofia, Bulgaria

⁴ Department “Agrochemistry and Soil Science”, “Afer Bulgaria” EOOD

Abstract: Chemical and microbiological analysis have been performed with various fertilizers from Agropolychim AD in order to determine their influence on winter common wheat and oilseed rape. The experiment was carried out in a greenhouse twice and the fertilizers were introduced during the pro-sowing period. The analysis of the investigated biogenic elements was performed during wheat's tillering phase and at the end of rape's rosette phase. The sample treated with Ammonium Nitrate of the wheat had the highest content of Ammonium Nitrogen, and the Nitrogen (Nitrate) was of the highest value when treated with Diammonium Phosphate. During the test with rapeseed the highest content of Ammonium Nitrogen was registered in the case of Urea - Ammonium Nitrate (UAN), while the values of Nitrogen (Nitrate) were the highest by the compound fertilizer NPK. The results also showed that the highest was the content of acquired Potassium as a result of applying NPK, in both crops. As a result of using MAP and DAP were reported the highest results for moving phosphates in the soil. The used fertilizers increased the biogenetics of the soils - the total microflora had higher values by the treated soil samples in comparison to the control sample, except of treatment wheat with MAP and rapeseed with Urea - Ammonium Nitrate (UAN). The highest percentage in the composition of the soil microflora held ammonifying bacteria (non-spore forming bacteria and bacilli), followed by actinomycetes and micromycetes.

Keywords: fertilizers, wheat, rapeseed, chemical and microbiological studies

1. Introduction

Maintenance and improvement of the quality of the soil, productivity in agriculture and the protection of the environment are crucial for the future of the nature and the generations. All agricultural practices can have both positive and negative effect in respect to chemical, biological and biochemical indicators of soil, as well as to the growth and vegetation of the cultivated crops. Fertilizers improve soil fertility and plant nutrition, which makes them necessary components in the agriculture (Boteva and Cholakov, 2009) and forestry (Bogdanov *et al.*, 2015), and the use of organic fertilizers provides a stable growth of the ecosystems (Kalidasu *et al.*, 2008; Kucińska *et al.*, 2008; Mostafa and Abo-Baker, 2010; Vlahova, 2015). Soil fertilizing increases reserves of nutrients in the upper layer of the soil, extends pH values and organic Carbon quantity thus enriching soil layers (Karcauskiene and Repsiene, 2009).

Changes in the content and composition of organic matter in the soil after fertilizing goes along with changes in the quantity and activity of the soil microflora (Giacometti *et al.*, 2013). Introduction of mineral fertilizers, in general, increases the total quantity of the micro-organisms in the soil (Milanov and Yorova, 1980; Donovan *et al.*, 1992; Prescott *et al.*, 1992; Hart and Stark, 1997; Forge and Simard, 2001; Meena *et al.*, 2014). Other authors find out that this increase is in short term, and is often followed by reduction of the microbial biomass and activity (Ohtonen, 1992; Smolander *et al.*, 1994; Périé and Munson, 2000).

Mineral fertilizers are usually applied to cereals, mainly to increase their yield. Increasing the production of plant biomass leads to the accumulation of residuals in the soil, thus mineral fertilizers may also affect the properties of the soil (Dick, 1992; Green *et al.*, 1995; Rasmussen *et al.*, 1998). Evaluating the effects of organic and mineral fertilizers and their combined application has a positive effect on determining the quality of the soil and contributes to the development of more suitable agricultural production systems, contributing to prevent deterioration of the physical, chemical and biological indicators of the soil.

Changes in microbial and biochemical properties may represent early and sensitive indicators for the management of induced modifications in respect quality of the soil, as they appear for shorter periods of time compared to decomposition of organic matter (Dick, 1992; Bending *et al.*, 2004; Winding *et al.*, 2005).

The objective of this study is to follow up the influence of various fertilizers of "Agropolychim" AD on the chemical and microbiological indicators by winter common wheat and oilseed rape.

2. Material and Methods

The experience is carried out in the autumn of 2014 in non-adjustable polycarbonate greenhouse of the Technical University – Varna in 30/30 cm pots twice under following scheme:

I. Wheat and II. Rapeseed - treated with:

- Nitrogen (Nitrate), Ammonium Nitrate, NH_4NO_3 ;
- Diammonium Phosphate (DAP);
- Monoammonium Phosphate (MAP);
- Urea - Ammonium Nitrate (UAN);
- Urea;
- Compound fertilizer NPK (NPK 14:14:14 + 11.5S);
- Control sample, no fertilizing.

The fertilizers were introduced during the pro-sowing period, and the fertilizing rate was 5 kg active substance (for wheat) and 3 kg active substance (for rapeseed), recalculated toward the volume of each of repetitions.

Before fertilizers introduction an agrochemical analysis was performed to determine the contents of:

- Ammonium Nitrogen ($\text{NH}_4 - \text{N}$);
- Nitrogen (Nitrate) ($\text{NO}_3 - \text{N}$);
- Phosphorus (P_2O_5);
- Potassium (K_2O).

The content of Ammonium Nitrogen ($\text{NH}_4 - \text{N}$) was determined photometrically with Indophenol blue as a result of extraction by Calcium dichloride solution (CaCl_2). Nitrogen (Nitrate) ($\text{NO}_3 - \text{N}$) was determined photometrically with Indophenol blue as a result of extraction by Calcium dichloride solution (CaCl_2).

The content of Phosphorus and Potassium was determined using the Double-lactate method of Egner-Rheem. The method is based on extraction of the movable compounds of Phosphorus and Potassium in a solution of Calcium lactate ($(\text{CH}_3\text{CH}_2\text{OH.COO})_2\text{Ca}$, which was buffered with hydrochloric acid to pH 3.5-3.7 by soil-solvent ratio 1:50 and interaction time of 90 min.

Laboratory analyzes were carried out in the Pedology laboratory of TU - Varna. In Table 1 are presented the limit values for soil reserves of available Nitrogen compounds, movable Phosphates and acquired Potassium.

Table 1: Limit values for soil reserves of available Nitrogen compounds, movable Phosphates and acquired Potassium

Reserve	Low	Average	Good
Total N mg/kg	up to 40	40 - 80	over 80
P_2O_5 mg/100g	up to 10	10 - 15	over 15
K_2O mg/100g	up to 8	8-16	over 16

In wheat's tillering phase and at the end of rapeseed's rosette phase soil sampling was taken for analysis of the examined biogenic elements by each repetition.

The analysis of Ammonium Nitrogen and Nitrogen (Nitrate), movable Phosphates and acquired Potassium was carried out at the end of February 2015.

Statistical processing of data, including dispersive analysis for the calculation of the smallest demonstrated differences between the options by $p=0.05$ ($\text{LSD}_{0.05}$) and the values of variable coefficients (VC) was carried out by means of STATISTICA 10.0 software product.

Samples for microbiological analysis were taken with sterile instrument, in sterile paper envelopes. They were transferred and examined not later than 48 hours, and at the time of culture they were stored in refrigerator by 4-10 °C.

Microbiological studies include determining of ammonifying bacteria (non-spore forming bacteria, bacilli), actinomycetes, micromycetes, bacteria, assimilating mineral nitrogen. They were determined using the method of dilution and culture of solid food environment (mesopeptonic agar - for determination of non-spore forming bacteria, bacilli; starch-ammonia agar - for determination of actinomycetes and bacteria, assimilating mineral nitrogen; environment of Chapek-Docks medium - for determination of micromycetes), cultivation in thermostat and subsequent reporting of colony forming units, converted to 1 g absolutely dry soil.

Statistical processing of the data from the microbiological indicators include calculating the average value of three repetitions and coefficient of variation by the use of Excel 2010.

3. Results and Discussions

Data obtained from the soil analysis before the fertilizers introduction are: Ammonium Nitrogen ($\text{NH}_4 - \text{N}$) - 5.30 mg/kg soil, Nitrogen (Nitrate) ($\text{NO}_3 - \text{N}$) - 20 mg/kg soil; acquired Potassium - 44.63 mg/100 g soil; movable Phosphates - 54.68 mg/100 g soil; soil reaction (pH) is slightly acidic ($\text{pH}=6.5$). Therefore the soil was poorly supplied with Nitrogen and well supplied with Phosphorus and Potassium, and the soil reaction will be friendly for crops growth. In Table 2 are given the results of the content of Ammonium and Nitrate ions in the examined soil samples.

Table 2: Content of the Ammonium and Nitrogen (Nitrate) in the examined soil samples

Fertilizers options	pH	Wheat				pH	Rapeseed			
		NH ₄ , mg/kg		NO ₃ , mg/kg			NH ₄ , mg/kg		NO ₃ , mg/kg	
		Average	VC	Average	VC		Average	VC	Average	VC
NH ₄ NO ₃	6.95	7.75	2.74	26.12	0.11	6.89	5.90	1.44	14.95	0.64
DAP	6.96	6.45	5.48	28.15	0.50	6.41	6.06	0.23	15.17	0.65
MAP	6.63	6.11	0.23	25.66	0.06	6.91	6.07	0	15.04	0.19
UAN	6.84	6.54	1.73	26.33	1.07	6.89	7.27	1.75	14.56	0.24
Urea	6.95	7.57	0.19	18.92	0.45	6.83	6.14	0.46	15.29	0.51
NPK	6.71	7.42	3.81	18.95	0.52	6.69	5.72	1.61	15.93	0.18
Control sample	6.98	5.23	0.54	15.96	0.58	7.00	5.12	0.14	13.85	0.10
LSD _{0.05}		0.88		0.46			0.17		0.23	

From the soil analysis of *wheat* it was found that the fertilizing option with Ammonium Nitrate had the highest content of Ammonium Nitrogen (7.75 mg/kg), followed by the options with introduction of Urea (7.57 mg/kg) and NPK (7.42 mg/kg), and there was no statistically proven difference in between. By applying DAP was reported a higher heterogeneity of the data for Ammonium Nitrogen and the lowest one was by applying Urea. The highest value in regards with Nitrogen (Nitrate) was registered by the option with DAP (28.15 mg/kg), which definitely exceeds next coming options with UAN 26.33 (mg/kg), NH_4NO_3 (26.12 mg/kg), and the rest in the test. There is an impression that when fertilizing with Urea and NPK it was discovered a lower content of Nitrogen (Nitrate) in the soil. The data obtained for this Nitrogen state due to the use of different fertilizers has a small deviation among the two repetitions.

The highest content of Ammonium Nitrogen by the test with *rapeseed* was recorded when fertilizing with UAN (7.27 mg/kg), where the discrepancy with the other options were statistically proven. When using UAN was recognized the biggest variation between the repetitions. For this Nitrogen state close values had the options with introducing Urea (6.14 mg/kg), MAP (6.07 mg/kg) and DAP (6.06 mg/kg). The results were lower when fertilizing with NH_4NO_3 and NPK. According to information from "Agropolychim" AD, Nitrogen losses were appr. 30 % less by fertilizing with UAN compared to Ammonium Nitrate and Urea (<http://agropolychim.bg/produkti/azotni-torove/techen-azoten-tor/>). The analysis of Nitrogen (Nitrate) content showed the highest values by applying NPK (15.93 mg/kg), definitely higher in comparison with the use of other fertilizers. Similarly, like by using Ammonium Nitrogen, close values had the options with Urea (15.29 mg/kg), DAP (15.17 mg/kg), and MAP (3.04 mg/kg). The results were the lowest when fertilizing with NH_4NO_3 and UAN. The variation of the data for this state of Nitrogen between the two repetitions of the fertilizers was small.

The soil reaction in all samples was from low acid to neutral (pH=6.41-7.00). The use of these fertilizers leads to neutrality regarding acidification of the soil. Urea, which ammonifies to Ammonium Carbonate under the influence of urobacteria in the soil, causes an alkaline reaction and neutralizes the acidic reaction of Nitrogen (Nitrate) (<http://agropolychim.bg/produkti/azotni-torove/techen-azoten-tor/>).

In Table 3 are presented the results for mobile phosphates. As a result of the used fertilizers DAP and MAP were red the highest results for movable Phosphates in the soil (respectively 69.46 mg/100 g and 68.97 mg/100 g in *wheat*, and 67.06 and 66.94mg/100 g in *rapeseed*). Between MAP and DAP there was no statistically proven discrepancy, but there in one among them and the other options. The obtained values were lower in the experiments by introduction of NPK (by wheat - 60.58 mg/100 g and by rapeseed - 59.26 mg/100 g). By the options of applying NH_4NO_3 was observed the lowest content of the nutrient element (53.06 mg/100 g by wheat, 52.16 mg/100 g by rapeseed). It was found out that by the agrochemical analysis of individual repetitions in both crops were obtained close values for the

movable Phosphates and the evidence for that are the low values of the variable coefficients. As a result of the used fertilizers DAP and MAP were red the highest results for movable Phosphates in the soil (respectively 69.46 mg/100 g and 68.97 mg/100 g in *wheat*, and 67.06 and 66.94mg/100 g in *rapeseed*).

Table 3: Content of movable Phosphates in the examined soil samples

Fertilizers options	Wheat		Rapeseed	
	P ₂ O ₅ , mg/100 g		P ₂ O ₅ , mg/100 g	
	Average	VC	Average	VC
NH_4NO_3	53.06	0.88	52.16	0.88
DAP	67.06	0.06	66.94	0.03
MAP	69.46	0.09	68.97	0.03
UAN	53.16	0.09	52.86	0.04
Urea	54.60	0.56	53.91	0.07
NPK	60.58	0.93	59.26	0.06
Control sample	51.13	0.07	50.06	0.07
LSD _{0.05}	1.44		6.40	

Between MAP and DAP there was no statistically proven discrepancy, but there in one among them and the other options. The obtained values were lower in the experiments by introduction of NPK (by wheat - 60.58 mg/100 g and by rapeseed - 59.26 mg/100 g). By the options of applying NH_4NO_3 was observed the lowest content of the nutrient element (53.06 mg/100 g by wheat, 52.16 mg/100 g by rapeseed). It was found out that by the agrochemical analysis of individual repetitions in both crops were obtained close values for the movable Phosphates and the evidence for that are the low values of the variable coefficients.

The highest statistically reliable content regarding acquired Potassium (Table 4) was found out during the test with *wheat* by the option with application of NPK (49.24 mg/100 g). The options with the use of the MAP (43.36 mg/100 g) and DAP (42.65 mg/100 g) show close values. The lowest results were recorded by applying NH_4NO_3 (37.46 mg/100 g). The largest variation of the data was found by the use of UAN and the results in both repetitions by using NPK are identical.

The results by *rapeseed* also show that the highest content of acquired Potassium was as a result of fertilizing with NPK (42.74 mg/100 g). The option with the use of Urea (41.25 mg/100 g) was the second one, as between them there was no proven difference. As a result of the use of the remaining fertilizers were red lower values than the recorded ones, with minimum discrepancies among the individual fertilizers. As a result of the use of DAP was reported greater variation of the data for the acquired Potassium, and by the Urea there was no difference in the values of both repetitions.

Table 4: Content of acquired Potassium in the examined soil samples

Fertilizers options	Wheat		Rapeseed	
	K ₂ O, mg/100 g		K ₂ O, mg/100 g	
	Average	VC	Average	VC
NH ₄ NO ₃	37.46	0.83	34.01	0.12
DAP	42.65	1.66	33.87	1.88
MAP	43.39	0.49	35.80	1.58
UAN	36.12	3.76	34.28	0.21
Urea	40.85	1.73	41.25	0
NPK	49.24	0	42.74	1.59
Control sample	36.09	3.92	31.33	0.41
LSD _{0.05}	2.54		1.49	

The results of the microbiological analysis are presented in Table 5. Biogenity (total microflora) of the soil samples was calculated in the aggregate of the quantity of non-spore forming bacteria, bacilli, actinomycetes and micromycetes. It is higher in the fertilized samples (with the exception of applying MAP by wheat and UAN by rapeseed), in

comparison with the non-fertilized control sample, laid down at the beginning of the experiment. The total quantity of microorganisms by the rapeseed is higher in four out of six fertilizing options - with Ammonium Nitrate (NH₄NO₃), MAP, Urea and NPK. The quantity of microorganisms is close when fertilizing both crops with DAP, while by fertilizing with UAN total microflora by wheat was 1.6 times more than by rapeseed. The best growth of microorganisms was established by fertilizing with Ammonium Nitrate of both examined crops, and the total microflora by rapeseed was 1.6 times more compared to wheat. Rapeseed is a crop which is distinguished with a strong exigency to Nitrogen (Bulletin for plant protection service 18, 2014). The total Nitrogen content in this fertilizer as per Agropolychim AD information is 34 %, and the plants use 35 % to 50 % of the applied Nitrogen, and about 20-30 % of fertilizers Nitrogen is immobilized by soil microorganisms (<http://agropolychim.bg/produkti/azotni-torove/amoniev-nitrat/>).

Table 5: Qualitative and quantitative composition of microorganisms (cfu x 10³/g abs. dry soil) ± C.V.; (%)

No	Crop	Fertilizers options	Non-spore forming bacteria	Bacilli	Actino-mycetes	Micro-mycetes	Bacteria, assimilating mineral nitrogen	Total micro-flora	Coefficient of mineralization
Control sample	Without crop - soil sample at the beginning of the experiment (soil + substrate)	No fertilizer applied	2822,4 ± 0,056 (67,3)	529,2 ± 0,520 (12,6)	784,0 ± 0,128 (18,7)	58,8 ± 0,260 (1,4)	3684,8 ± 0,079	4194.4	1.10
1	Wheat	NH ₄ NO ₃	4312,0 ± 0,061 (67,9)	1568,0 ± 0,077 (24,7)	392,0 ± 0,513 (6,1)	78,4 ± 0,575 (1,2)	3371,2 ± 0,080	6350.4	0.57
2		MAP	1920,8 ± 0,083 (61,3)	882,0 ± 0,300 (28,1)	254,8 ± 0,408 (8,1)	78,4 ± 0,884 (2,5)	1489,6 ± 0,131	3136.0	0.53
3		DAP	3528,0 ± 0,057 (62,9)	1470,0 ± 0,068 (26,2)	490,0 ± 0,072 (8,7)	117,6 ± 0,340 (2,1)	2665,6 ± 0,062	5605.6	0.53
4		UAN	4508,0 ± 0,044 (73,7)	1215,2 ± 0,214 (19,9)	352,8 ± 0,255 (5,8)	39,2 ± 0,510 (0,6)	3880,8 ± 0,054	6115.2	0.68
5		Urea	4390,4 ± 0,036 (86,2)	215,6 ± 0,881 (4,2)	470,4 ± 0,096 (9,2)	19,6 ± 1,020 (0,4)	2704,8 ± 0,067	5096.0	0.59
6		NPK	3704,4 ± 0,066 (76,5)	235,2 ± 0,319 (4,9)	588,0 ± 0,340 (12,1)	313,6 ± 0,271 (6,5)	1960,0 ± 0,276	4841.2	0.50
1	Rapeseed	NH ₄ NO ₃	8780,8 ± 0,032 (84,4)	842,8 ± 0,142 (8,1)	588,0 ± 0,187 (5,7)	196,0 ± 1,020 (1,9)	5958,4 ± 0,054	10407.6	0.62
2		MAP	5488,0 ± 0,069 (79,5)	1117,2 ± 0,157 (16,2)	215,6 ± 0,278 (3,1)	78,4 ± 0,830 (1,1)	5017,6 ± 0,060	6899.2	0.76
3		DAP	4076,8 ± 0,080 (74,6)	1117,2 ± 0,091 (20,4)	235,2 ± 0,170 (4,3)	39,2 ± 0,884 (0,7)	4939,2 ± 0,049	5468.4	0.95
4		UAN	2744,0 ± 0,146 (70,4)	705,6 ± 0,113 (18,1)	333,2 ± 0,060 (8,5)	117,6 ± 0,978 (3,0)	3449,6 ± 0,096	3900.4	1.00
5		Urea	7760,0 ± 0,024 (93,2)	485,0 ± 0,052 (5,8)	58,2 ± 0,695 (0,7)	19,4 ± 1,813 (0,2)	5917,0 ± 0,045	8322.6	0.72
6		NPK	8232,0 ± 0,036 (92,7)	470,4 ± 0,223 (5,3)	137,2 ± 0,474 (1,5)	39,2 ± 0,897 (0,4)	5174,4 ± 0,046	8878.8	0.59

The reduction of the total quantity of microorganisms in rapeseed for the remaining fertilizers has the following descending order: NPK > Urea > MAP > DAP > UAN and by wheat: UAN > DAP > Urea > NPK > MAP. Hence, solely when fertilizing with Ammonium Nitrate the trend was the same in both tested crops - wheat and rapeseed, and by rapeseed this fertilizer activates more strongly the growth of microorganisms. The lowest quantity of microorganisms

by the application of UAN to rapeseed correlates with the lowest content of the tested elements of Nitrogen (Nitrate), acquired forms of Potassium and Phosphorus. While by wheat the content of these nutrients is higher was higher when using UAN, which presumes also higher quantity of microorganisms in this sample (second position). This fertilizer contains three forms of Nitrogen: amid, ammonium and nitrate, which implies more even and prolonged

delivering of the active substance and reduces the percentage of denitrification (<http://agropolychim.bg/produkti/azotni-torove/techen-azoten-tor/>). The higher quantity of Ammonium Nitrogen and Nitrogen (Nitrate), movable forms of Potassium and Phosphorus however by application of NPK by wheat impedes the growth of microorganisms. The highest determined values of movable Phosphates by the application of the fertilizers DAP and MAP are not sufficient for the most significant activation in the growth of microorganisms. The values of Nitrogen (Nitrate) are the lowest when using Urea by wheat and of Ammonium Nitrogen when using the same substance by rapeseed. The Phosphorus and Potassium contents in these samples is the average relative to the other samples. These results define the middle place of Urea in the displayed fertilisers test with wheat and rapeseed.

The increased biogenity of the treated with fertilizer soil samples can be explained by the actual result of fertilizing, including through a more active root exosmosis, which contributes to the growth of soil microorganisms. The deep and fast-growing root system of rapeseed stimulates microbiological activity improves the soil structure enhances water penetration and aeration. It is the best preparation for the wheat, which reduces the damage caused by root's putrefy of the wheat thus increasing the yield with 20-30 % (Bulletin for plant protection services 18, 2014). For the massive root system of rapeseed is known that the roots reach 2-2,5 m depth and the total length of the root branches with the root hair reaches 100 km. The root system is the factory of the plant. There are processed and synthesised the nutrient compounds for the growth, incl. for the formation of the grain (Koedjikov, 1975).

The highest percentage in the composition of the total microflora occupy non-spore forming bacteria by the control sample as well as by the treated with fertilizer samples. Secondly, by rapeseed is the percentage of bacilli, followed by actinomycetes. By the control sample, as well as by fertilizing the wheat with NPK and Urea actinomycetes quantity was higher then to bacilli quantity. Micromycetes were the least presented in the overall composition of microflora for all test samples. Fertilization activates most non-spore forming bacteria, followed by bacilli. The amount of these groups of microorganisms by fertilization was generally higher the one of the control sample. They participate in the initial stages of degradation of organic matter. While the growth of actinomycetes was suppressed in all fertilizing options in both cultures relative to the control sample.

According to research by Bogdanov et. al (2015) micromycetes improve their growth in most fertilizing options, and this was particularly visible by full fertilization at an average rate of Nitrogen and high for Phosphorus and Potassium, but they were least presented in the overall composition of total microflora. The increased participation of ammonifying bacteria (non-spore forming bacteria and bacilli) in soil microbe synthesis shows that under the influence of the imported fertilizers was activated the flow of microbial processes associated with the transformation of organic Nitrogen compounds of the soil organic-mineral

complex. This in turn leads to enrichment of the soil with the plants digestible nutrients.

Compared to the control samples and fertilized wheat, the quantity of bacteria digesting mineral Nitrogen was higher in samples with rapeseed with the exception of the sample fertilized with UAN. The higher amount of these bacteria and the lower amount of non-spore forming bacteria and bacilli determined higher values of mineralization coefficient and respectively a higher rate of degradation of the organics. The highest was the value of the mineralization coefficient by the control sample and in the majority of samples with rapeseed.

4. Conclusion

In experiments with wheat were reported the highest levels of Ammonia Nitrogen as a result of fertilization with Ammonium Nitrate and Nitrogen (Nitrate) – when using Diammonium Phosphate. The highest was the content of mobile phosphates after fertilization with MAP and DAP, and of Potassium - as a result of fertilization with NPK.

By the test with rape the highest content of Ammonium Nitrogen was recorded by fertilization with Urea - Ammonium Nitrate (UAN), and of Nitrogen (Nitrate) - caused by the use of NPK. The results for the content of mobile phosphates and acquired Potassium were the same as by the test with wheat.

Treating with the used fertilizers increased the soil biogenetics - the total microflora had higher values by the fertilized soil samples compared to the control sample, with the exception of fertilizers MAP by wheat and UAN by rapeseed. A high amount of microorganisms, however, does not always imply a higher activity - the rate of degradation of the organics was highest in the control sample and on by fertilizing rapeseed with UAN.

Ammonifying bacteria (non-spore forming bacteria and bacilli) occupied the highest percentage in the overall composition of microflora in all soil samples.

The growth of actinomycetes was limited in all fertilizing options in both - wheat and rapeseed, relative to the control sample. Urea in rapeseed suppressed mostly their growth - 13.5 times compared to the control sample.

Micromycetes were least presented in the overall composition of microflora, both in the control as well as in the fertilized samples.

The amount of the bacteria, assimilating mineral nitrogen was lower when using fertilizers by wheat compared to that of rapeseed and non-fertilized control sample. This tendency is different only in fertilizing with UAN – by wheat it activated the growth of these microorganisms and their quantity was higher than that of the control sample, while UAN inhibits by rapeseed the growth of bacteria, assimilating mineral nitrogen and their amount thereof was the lowest compared to the other samples with rapeseed.

5. Acknowledgement

The carried out research is realized in the frames of the project BG161PO003-1.2.04-0045-C0001/20.08.2013, Operational Program "Development of the Competitiveness of the Bulgarian Economy" 2007-2013.

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