Changes in the Composition of Humus of Carbonate Chernozem under the Influence of Advanced Erosion Control Technologies

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Abstract: *Soil degradation process, loss of organic matter, has serious impact on soil quality and soil fertility. To combat it, as well as water erosion process in University of Ruse "Angel Kanchev" and ISSATPP "Nikola Pushkarov" were created advanced technologies for unconventional minimum tillage for cultivation of crops on sloping farmland. This work examines changes in the composition and properties of soil organic matter, under advanced technologies for minimum and unconventional tillage for corn cultivation on slope lands, on carbonate chernozem.*

Keywords: *soil humus, water erosion, humus composition, minimum tillage, compost, vertical mulching.*

INTRODUCTION

Water erosion causes huge losses on the economy of all affected parts in the world and in Bulgaria, with serious consequences in terms of loss of surface fertile soil horizons of arable land, which substantially deteriorates agrochemical properties and fertility of soil and yields of cultivated crops.

Another degradation process is the reduction of soil organic matter, related mainly to the removal of topsoil due to erosion, oxidation of organic carbon, high aeration under intensive tillage and degradation of soil structure. The negative effects arising from the reduction of organic matter in the soil are: deterioration of soil structure and water retention ability, as well as its productivity.

In all countries in the world and in Bulgaria, where exist problems with water erosion and loss of soil organic matter, are carried out systematic efforts for limiting these degradation processes, mainly using agricultural erosion control measures, methods and technologies.

To combat these two degradation processes in University of Ruse "Angel Kanchev" and ISSATPP "Pushkarov" were created advanced technologies for minimum and unconventional tillage for cultivation of crops on sloping farmland.

According Swift (1991) ability to manage the quantity and quality of soil organic matter is based on two assumptions. First, it is that the soil organic matter can be divided into several fractions each of which may be changed by the management of the lands. On the other hand, the decomposition and synthesis of each of the humic fractions is regulated by certain groups of the physicochemical and biological factors that can be changed by the practices and technologies for land use. Changes in soil organic matter can be determined by measuring changes in total soil organic matter and its chemical fractions, physical factions or combinations thereof (Lefroy, 1995).

The purpose of this work is to explore changes in the composition and properties of soil organic matter of soils exposed to water erosion and soil conservation application of certain events, such as surface and vertical mulching with ready compost.

MATERIALS AND METODS

The survey was conducted between 2012-2014 year in the experimental field of the Institute of soil science, agricultural technology and plant protection "N. Poushkarov "- Sofia, on the territory of Trustenik, Ruse region, without irrigation, on medium eroded carbonate chernozem, with an average slope of 5^0 (8, 7%).

To achieve the objective of the study was conducted field experiment, by block method with maize in four variants in four replications:

d_o - corn grown by conventional technology applied along the slope - control;

d_1 - corn grown by conventional technology applied across the slope;

d_2 - corn grown by erosion control technology, including surface mulching with ready compost implemented across the slope;

d_3 - corn grown by erosion control technology, including basic tillage without inversion of layer - loosening and erosion control measure vertical mulching with compost, cutting with making of molehills both during sowing and digging, and formation of furrows with cutting and making of molehills applied across the slope.

Soil protective operation vertical mulching was carried out with machine, which makes slots and molehills ЩН - 2-140 with depth of 0.40 m with compost on band scheme and distance between slots 1.4 m and interval between bands in field 5 m. Soil tillage operations were carried out in the direction perpendicular to the slope.

Samples for conducting agrochemical analyzes were taken in three stages: sowing, maximum growth stage and after harvesting. The humus content is determined by the method of Turin and composition of humus by the method of Kononova - Belchikova.

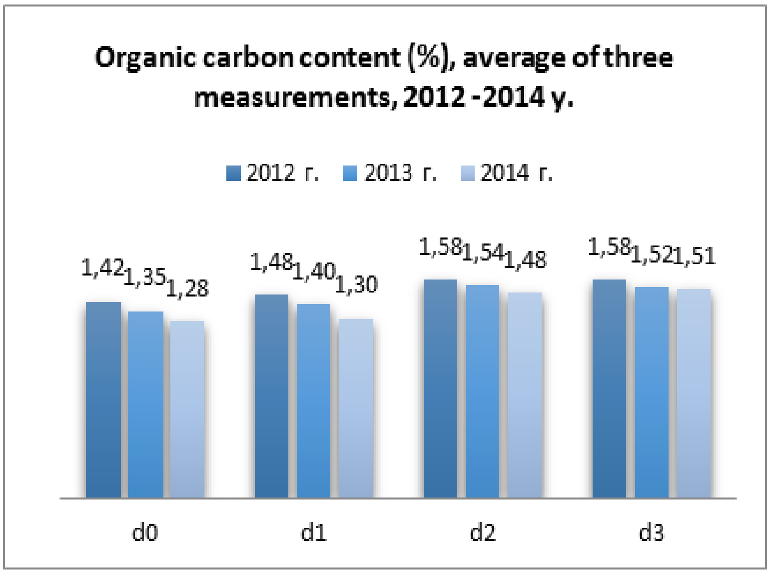
The chemical composition of applied composts is shown in table 1.

Table 1 Chemical composition of applied composts

Parameters, units	2012 - mulch	2013 - mulch	2014 - mulch
NH_4^+, mg/kg	1971.79	186,26	340,68
NO_3^-, mg/kg	753.80	99,46	2350,72
Total N, %	2.86	2,17	1,98
Total C, %	32.59	30,18	26,98
C/N	13.50	13,91	13,62
pH, H_2O	6.78	6,90	7,96
pH, KCl	6.62	6,71	7,71
EC, mS/cm	10.14	7,37	5,91
Available P_2O_5, %	0.441	0,389	0,480
Available K_2O, %	0.996	0,287	0,251

RESULTS AND DISCUSSION

Results of the research carried out show that in the application of unconventional erosion control methods surface mulching with ready compost and advanced technology for minimal tillage and vertical mulching with compost in the three years, the amount of organic carbon is higher than that in the control variant with conventional tillage applied along the slope. Both applied soil protective technologies have a positive impact on the amount of soil organic carbon (Figure 1). The same trend was reported in terms of the quantity of extracted by pyrophosphate method humic substances (Kononova-Belchikova).



P<0.0001HSD[0.05]=0.05; HSD[0.01]=0.06

Fig.1 Total soil organic carbon content (%).

Average for the period 2012-2014y., reported in the initial phase soluble humic substances in variant with advanced technology for minimum tillage with vertical mulching are 0.741%, while reported in control variant d_0 they are 0.488%. In the final stage, the results are respectively 0.513% and 0.418% (Table 2, Fig. 2). In the variant with conventional tillage and surface mulching, average of humic substances extracted with sodium pyrophosphate for the period in the final phase is 0.490%.

The amount of humic acid in the initial phase variant d_3 is 0.484%, while d_0 (control) is 0.289 %. In the final phase average of values are respectively 0.341% and 0.240%. As regards the bonded humic acids, again larger quantities were found in the last variant of the experience, the differences between it and other variants are statistically proven.

In determining the quantities of fulvoacids establishes a preponderance of the results for variants d_3 and d_2, with extractable 0,1 N sulfuric acid, particularly in the last two phases observed. Fulvoacids defined in 0.1 M pyrophosphate and 0.1 M NaOH, the average for three years period, at variants d_2 and d_3, are higher compared to d_1 and d_0. However, the amount of extracted humic acid is higher than amount of fulvoacids for variant with minimum tillage and vertical mulching with ready compost, compared to control d_0.

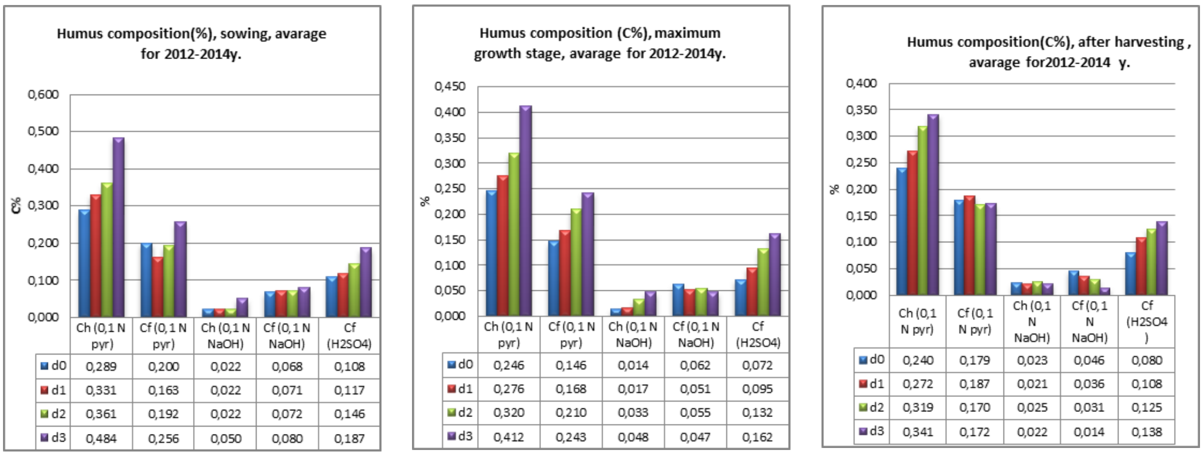


Fig.2 Composition of humus (C%).

Table 2 Composition of humus (C%)

Year	Phase	Variants	Organic carbon (%) extracted in 0,1N pyrophosphate				Organic carbon extracted in 0,1N, NaOH			C, 0,1N H_2SO_4, (%)
			C(%)	Ch(%)	Cf(%)	Ch/Cf	Ch	Cf	Ch - bonded	
2012	Sowing	d_0	0.598	0,387	0,211	1,83	0.033	0.118	0,354	0.104
		d_1	0.605	0,357	0,248	1,44	0,045	0,108	0,312	0.083
		d_2	0.669	0,343	0,326	1,05	0,051	0,106	0,292	0.088
		d_3	0.875	0,518	0,357	1,45	0.054	0.100	0,464	0.083
	Maximum growth stage	d_0	0.486	0.309	0.177	1.74	0.018	0.123	0,291	0.092
		d_1	0.520	0.317	0.203	1.56	0.017	0.092	0,300	0.070
		d_2	0.525	0.320	0.205	1.56	0.033	0.111	0,287	0.090
		d_3	0.576	0.342	0.234	1.46	0.042	0.049	0,300	0.079
	Harvesting	d_0	0.415	0.235	0.180	1.31	0.012	0.079	0,223	0.083
		d_1	0.455	0.260	0.195	1.33	0.014	0.070	0,246	0.086
		d_2	0.513	0.318	0.195	1.63	0.026	0.056	0,292	0.089
		d_3	0.540	0.331	0.209	1,58	0.028	0.044	0,303	0.089
2013	Sowing	d_0	0.517	0.255	0.262	0.97	0.017	0.084	0,238	0.152
		d_1	0.531	0.406	0,125	3,25	0.017	0.077	0,389	0.122
		d_2	0.538	0.435	0,103	4,22	0.025	0.074	0,410	0.146
		d_3	0.617	0.453	0.164	2.76	0.034	0.051	0,428	0.186
	Maximum growth stage	d_0	0.342	0.206	0.136	1.51	0.007	0.062	0,199	0.054
		d_1	0.570	0.282	0.187	1.51	0.016	0.034	0,266	0.069
		d_2	0.613	0.336	0.277	1.21	0.048	0.020	0,288	0.102
		d_3	0.797	0.482	0,315	1.53	0.030	0.006	0,452	0.115
	Harvesting	d_0	0.427	0.232	0.195	1.19	0.015	0.017	0,217	0.109
		d_1	0.485	0.250	0.235	1.06	0.016	0.006	0,234	0.109
		d_2	0.514	0.335	0.179	1.87	0.015	0.035	0,320	0.120
		d_3	0.526	0.365	0.160	2.28	0.012	0.019	0,353	0.182
2014	Sowing	d_0	0.350	0.224	0.126	1,78	0.016	0.001	0,207	0.069
		d_1	0.345	0.230	0,115	3,00	0.016	0.028	0,256	0,147
		d_2	0.453	0.305	0,148	2,06	0,025	0,035	0,270	0,203
		d_3	0.730	0.482	0.248	1,94	0.072	0.063	0,410	0.292
	Maximum growth stage	d_0	0.517	0.396	0.121	3.27	0.026	0.081	0,370	0.121
		d_1	0.533	0.370	0.163	2.27	0.037	0.050	0,333	0.129
		d_2	0.537	0.407	0.130	3.13	0.026	0.042	0,381	0.160
		d_3	0.724	0.597	0.127	4,70	0.052	0.082	0,545	0.169
	Harvesting	d_0	0.413	0.252	0.161	1.57	0.043	0.006	0,209	0.048
		d_1	0.439	0.307	0.132	2.33	0.033	0.002	0,274	0.130
		d_2	0.442	0.305	0.137	2.23	0.035	0.003	0,270	0.165
		d_3	0.474	0.326	0.148	2.20	0.027	0.003	0,299	0.144

ANOVA: Extracted C%: p=0.002091; HSD[0.05]=0.11; HSD[0.01]=0.14
Ch(%):p=0.000162; HSD[0.05]=0.06; HSD[0.01]=0.08
Ch bonded (%):P=0.003876; HSD[0.05]=0.07; HSD[0.01]=0.09;
Cf in pyrophosphate: p=0.145884

CONCLUSION

From the research results and analysis can be formulated following conclusions:

1. The content of organic matter at variants, where are applied erosion control measures - surface mulching with compost and minimum tillage with vertical mulching, is higher in comparison to the control, which means that the applied technologies counteract the soil degradation process - loss of organic matter.

2. Furthermore the applied advanced technology for unconventional minimum tillage affects the quality and composition of humus and increases the amount of soluble humic substances and humic acids.

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