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INFLUENCE OF STRAW ORGANICS ON CHARACTERISTICS OF SOIL FERTILITY AND BIOLOGICAL YIELD CAPACITY (BARLEY CASE STUDY)

SUMMARY

Monitoring soil productivity is a relevant issue in modern agricultural technologies. A particular interest is taken in evaluating the effect of straw combined with microorganisms and thus used as organics. To collect practical data, in 2012-2014 a microplot experiment was conducted on the territory of the Botanical Garden of Voronezh Agricultural University. The aim of the experiment was to study biological activity of leached chernozem (black earth). For this, straw combined with a special bacteria agent Baikal AM1 was ploughed up in a fallow plot. It was found that annual use of such a combination can increase the organics amount of soil by 1,3 as much. All the variants demonstrate the significant increase in urease, while catalase activity varied only slightly. The variants with straw processed with microorganisms show the increase in phosphotase and invertase.

Analysis of the total microorganisms' amount grown in SAA (starch-and-ammonia agar) and MPA (meat-and-peptone agar) reveals the transformation of soil organics. Both the lowest and highest figures were found across the tested plots. The plots with both straw and microorganisms demonstrated the highest productivity, grain content and ear output, thus showing better prospects for yield capacity. In the short term, this study is supposed to launch forecasting both soil productivity and yield capacity in different regions of Russia.

Key words: Soil fertility, chernozem, Russia

INTRODUCTION

In the last few years Russia has considerably increased its cattle livestock, which additional-ly aimed at increasing manure input in the fields. In Black-earth region, for example, this figure has grown from 20,000 to 90,000. Yet, the amount of organics to supply the fields is still 10-30 times less as required. Thus, one of the most acute and relevant problems that farmers encounter today is the search for effective agro-technological alternatives to make up for organics. It is even more im-portant now that we have such intensive arable land chemicalization and high power/weight ratio per a tillage unit. These cause inactive changes in the amount of soil micro biota and its efficiency. One of the

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possible solutions to these problems could be the use of crop straw left after harvesting.

We believe it can serve as organics, especially when combined with microbiological agents. In this way we can intensify the soil humification. Diagnosis of soil micro biota amount and its efficiency is considered to be an important integral part of bio fertility (Mishustin, 1972, 1975, Mishustin et al., 1987; Zvyagintsev, 1987).

It can show the humus ratio depending on using straw and microbiological agents, thus enabling us to monitor bio conditions of soil and forecast the potential plant growth efficiency (Bezler and Cherepukhina, 2012; Verzilin et al., 2005).

MATERIAL AND METHODS

To reach the goals mentioned above, an experiment was conducted in the field-trial plot of Voronezh Agricultural University in 2012-2014. It aimed at studying elements of biological activity of leached chernozem (leached black earth). The test area structure was characterized by the fol-lowing variants:

1. Control plot (C); 2. C+barley; 3. C+straw; 4. C+straw+ microorganisms +barley; 5. C+straw+ microorganisms +barley + microorganisms. A fallow plot was used as the control plot. In autumn, the straw combined with a microbiological agent Baikal AM1 (300 litres/ha) was ploughed up in the fallow plot. The seeds were treated by microorganisms (10 litres/ metric tons), and seed application rate was 500 seeds/m2.

The ground soil of the field-trial area was a leached medium-humic chernozem with high concentration of P and K (see Table 1). This soil type is considered the most fertile.

The number of different kinds of bacteria was estimated on the basis of meat-and-peptone agar (MPA), starch-and-ammonia agar (SAA), Czapek's medium, Ashby medium and Getchinson medium. The time period of bacteria amount estimation depended on the composition of the medi-um used as well as the particular group of estimated bacteria. The enzyme activity was estimated on the basis of traditional methods (Khaziev, 1976, Kolsanov et al., 2006).

RESULTS AND DISCUSSION

Table 1 shows how growth of barley and using straw as organics changed agrochemical characteristics of soil. All the variants (plots) demonstrated the increase of humus. Interestingly, the increase (0,5%) could be observed on the plot where only straw was used as organics. The annual application of straw generally increased the amount of organics 1,3 as much.

The variant treated by Baikal AM1 also demonstrated the increase in humus 1,2 as much. Variants 4 and 5 showed increase in available P and K by 2 and 42 %, respectively.

Table 2 shows the enzyme activity of soil by the variants.

Table 1. The amount of humus and other elements of leached chernozem in the test area (2012-2014)

Variants	Amount of humus, %	Amount of mg/кg	
		P2O5	K2O
1.	3,61	115	78
2.	4,05	112	83
3.	4,72	128	101
4.	4,37	117	111
5.	4,39	118	109

Table 2. The enzyme activity of soil

Variant	Urease	Catalase	Phosphatase	Invertase
1.	20,0	2,20	20,7	6,0
2.	32,0	1,75	18,9	11,7
3.	42,0	2,35	21,6	8,7
4.	36,0	2,45	23,9	13,5
5.	40,0	2,75	30,6	17,1

The units of the enzyme activity: Urease - mg N-NH4 per 10g of soil per 24 hrs, Catalase - ml 0,1M KMnO4 per 1g of soil per 20 minutes, Phosphatase – mg P2O5 per 10g of soil per hour, Invertase – mg glucose per 1g of soil per 24 hrs.

All the variants demonstrated high activity of urease, which we assume was due to a considerable supply of organics to the soil. The organics was a substrate for enzymes and the medium for bacteria. According to the research results, variant 3 showed the highest enzyme activity in the soil.

Catalase activity showed a slight activity across different variants. The application of straw led to a slight decrease in catalase activity, which might be due to insufficient amount of anaerobic cellulose-fermenting bacteria.

Phosphatase plays a very important part in providing plants with nutrients. We could observe some increase in its activity in variants 3, 4 and 5 after application of straw treated with microorganisms.

Invertase activity was estimated by identifying the amount of organics in the soil. The invertase activity of soil is one of the main criteria showing the bio activity of the soil, or its biological capacity. Only variant 5 demonstrated the increase in the invertase activity, which means the increase in easy hydrolysable carbohydrates due to the application of straw.

Table 3 shows the data about concentration of different groups of microorganisms in the tested soil.

We can judge about the process of organics transformations in the soil by the proportion between the total volume of microorganisms, utilizing mineral

nitrogen, and the volume of microorganisms, assimilating organics nitrogen (SAA:MPA). After application of straw, the lowest figure of this proportion was demonstrated when the straw was treated by Baikal AM1, whereas the highest (2,8 as high) was observed for the control plot. It implies intensive soil mineralization.

Table 3. The amount of microorganisms in the soil (104 cfu/g of absolutely dry soil on various types of mediums) 2012-2014 yrs.

Variants	Medium Type					
	MPA	SAA	Czapek	Getchinson	Ashby	SAA/MPA
1.	103	235	54	10	35	2,3
2.	134	186	23	56	8	1,4
3.	110	163	73	18	58	1,4
4.	176	168	51	53	27	0,9
5.	189	153	72	88	55	0,8

The data in Table 4 demonstrate the positive effect on the yield capacity after application of Baikal AM1 to the seeds and later to the straw.

Table 4. Formation of structure elements of the barley yield

Variants	Number of the sample stems/ culms	Number of the productive sample stems/ culms	Productive tilling capacity	Total number of stems/ culms (productive, unfertile stems, grease)	Overall tilling capacity	Height, cm.	Number of grains.*	Grain mass, gs.*	Grain content*	Ears output.,gs*	Sample grain mass, gs.	Plant output	Mass of 1000 grains, gs.
1	226	203	0,9	514	2,3	55	539	24,4	21,6	1,0	148,2	0,66	41,6
2	233	214	0,9	540	2,3	65	825	37	33,0	1,5	171,4	0,74	43,2
3	235	215	0,9	560	2,4	65	894	44,8	35,8	1,8	185,0	0,79	44,2

1.Ground+barley; 2.Ground+straw+microorganisms+barley; 3.Ground+straw+microorganisms+ barley + microorganisms.

* Test of 25 ears

The straw variants treated with microorganisms showed increase in productive stems, grain content and ears output. The mass of 1000 grains proved

to be the most stable indicator, but as the result of other characteristics improvement, total grain mass of sample plots increased from 148, 2 g to 185g. By the harvesting time, 1 m^2 (variant 1) had had 514 productive stems, and after application of microorganisms (variants 2-3) - 540 и 560 stems, respectively. The highest yield figure (18,5 dt/ha) was observed for variants where both straw and bacteria were applied. Variant 1 produced only 14,8 dt/ha.

CONCLUSIONS

It can be concluded that research revealed a positive fertility effect that straw application produces on leached chernozem. The study also showed that it enhanced the highest effect on barley yield capacity and organics increase was achieved through application of Baikal AM1 to both, the seeds and the straw. Such sample plots demonstrated increase in enzyme activity. The cor-relation of autochthonous and zymogenous micro biota decreases as further from the control plot. The lowest figure (0,8) is observed after application of straw and seeds treated with microorgan-isms. The study results prove that application of Baikal AM1 enhanced grain content, ears output and, therefore, yield capacity.

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