The Impact of Biocompost (Bioameliorators) on Microbioceonosus

Biyokompostun Toprak Mikroorganizmalarına Etkisi

Research Article

A. Gulmira Babaeva
A.Yasawi International Kazakh-Turkish University, Faculty of Science, Department of Biology, Turkestan, Kazakhstan

ABSTRACT

It was found out by carrying out laboratory researches that intensity of cellulose and hemicellulose decomposings by enzyme systems of soil microorganisms is accelerated on combined introducing them with mineral fertilizings and a favorable condition is formed for young-growth humus formation.

Key Words
Biocompost, soil microorganisms, rice fields, *Cellulomonas effuse, Bacillus cytaseus*

ÖZET

Laboratuvar çalışmaları, toprak mikroorganizmalarındaki enzim sistemleri tarafından parçalanan selüloz ve hemiselülozun mineralli gübrelerle birlikte kullanıldığında etkisinin arttığını ve yeni humus oluşumunu hızlandırarak elverişli bir durum oluşturduğunu göstermiştir.

Anahtar Kelimeler
Biyokompost, toprak mikroorganizmaları, pirinç tarlaları, *Cellulomonas effuse, Bacillus cytaseus*

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Correspondence to: A. Gulmira Babaeva, A.Yasawi International Kazakh-Turkish University, Faculty of Science, Department of Biology, Turkestan, Kazakhstan
Tel: +008 705 161 79 51 Fax: +007 725 336 36 05 E-Mail: gulmirababaeva@mail.ru

INTRODUCTION

There are some associations of microorganisms in the inundated soil, being a part of microbial coenosis, taking active part in anaerobic decomposing one of the main components of vegetable residues-cellulose. The ability of microorganisms to canker cellulose is considered by many researchers as one of the most important indications of its biological activity and therefore they can be used as indications of soil fertility [1-4].

In the conditions of inundated meadow-boggy soil of Kyzylorda Oblast, differing with high speed of mineralization processes, the researches of cellulose decomposing in the form of compost by soil microorganisms are of wide interest in the view of mineralization of vegetable residues introduced into the soil.

According to E.N. Mishustin and others [5], nitrogen-fixating organisms enrich the cultivated soil yearly not less than $4x10^6$ ton of nitrogen. Thus, an Indian researcher G. Venkataraman [6] determines that per a unit of non-symbiotic nitrogen fixation, it has about $90-10^{15}$ tons per year, 50% from total production of microbiological nitrogen fixation in the biosphere.

If we extrapolate these data, we see that total contribution of biological nitrogen in agriculture is approximately $8x10^6$ ton per year.

The intensity of vital activity of non-symbiotic nitrogen fixing microorganisms depends on energy substratum content in the soil, the role of which is performed by vegetable residues. Therefore, one of the effective agrarian methods is introducing the straw into the soil and other vegetable residues. The authors suppose as well, that the atmospheric nitrogen can fix up to 70% of soil microorganisms [7].

The aim of researches was to determine the number and the role of soil nitrogen-fixing and cellulose-destroying microorganisms on introducing various organic materials in the form of biocompost and poultry droppings.

MATERIAL AND METHODS

The objects of our researches were meadow-boggy soils of rice-sowing farms of Kyzylorda Oblast. Field experiments were put during 2006-2008 years in the territory of Karaultyubinsk FEF (Field Experiment Farm) of Kazakh SRI (Scientific Research Institute) of rice. The size of experimental plots was 6 m^2. The norm of seeding seeds was 250 kg/hectare. The sort was "Marzhan". The soil samples for analysis were selected by soil drilling from plough layer of the soil three times during vegetative period of rice. The frequency of experiment is triple. The establishment of field experiments were fulfilling according to the recommendations of B.A. Dospehov [8].

The number of nitrogen-fixing microorganisms were considering on the medium of Emtsev, anaerobic cellulose-destroying- Kuvin, with applying the method of limiting dilutions by means of Mac-Kredi table [9].

Composting rice straws were fulfilling in anaerobic conditions with the usage of strains of *Cellulomonas effuse* bacteria **ВКМП-4465** and *Bacillus cytaseus* bacteria **ВКМП-4441** at the rate 10^4 cells on 1gr of substratum. The norm of poultry dropping introduced into the soil was 2 tons/hectare (1^{st} dosage) and 4 tons/hectare (2^{nd} dosage).

The least significant difference was determined for statistical processing of received digital data.

RESULTS AND DISCUSSION

The total number of anaerobic cellulose-destroying microorganisms was one of the main indications, characterizing intensity of their vital activities and the rate of soil fertility of rice fields, otherwise anaerobic decomposing of vegetable residues had resulted in accumulating metabolism products, which had contributed the synthesis of humus substances.

The intensive development of cellulositic microorganisms had contributed to more active process of decomposing of organic materials as a whole, in particular the cellulose in them.

Especially, it was clearly shown on favorable combination of temperature and moisture in the soil, and plants contributions with the recourse of organic and mineral nutrition.

It was known that the decomposition products of cellulose were used by other groups of microorganisms, the vital activities of which were inseparably linked with soil enrichment by biogenic and mineral elements. Hence, cellulose-destroying microorganisms can be used as indications of biological activity and soil fertility.

As shown from the data of Table 1, the soil of monitoring variant is extremely poor with cellulose-destroying microorganisms -1.53x10^6 /gr of soil. Since organic materials had been introduced in the form of biological compost and poultry droppings their number had been rapidly increased. Particularly, in the variants with introduction of composted straw together with the various dosages of poultry droppings.

So, in the beginning of rice vegetation in the variants Sample+CS^4 +PD (1^{st} dosage) and Sample+ CS^4 +PD (2^{nd} dosage) the number of anaerobic cellulose-destroying bacteria were revealed, accordingly 15,4 and 14.32x10^6/gr of soil, whereas 1.53x10^6/gr of soil in the monitoring. The variant where only mineral fertilizers were introduced, number of bacteria was 2.02x10^6/gr of soil, which was almost more than in monitoring.

The great population of anaerobic bacteria was also observed on introducing composted straw and poultry droppings separately. The number of cellulose-destroyings was revealed within 6.12-8.08 x10^6/gr of soil in these variants of field experiment. LSD – least significant difference is applied for statistical analysis and shows the deflection of digital data.

A rapid growth in the number of cellulose-destroying microorganisms was observed in the middle of rice vegetation, i.e. in July particularly. So, in the sample of mineral fertilizers the population of bacteria was increased from 17.4x10^6 /gr to 92.04x10^6/gr of soil. It was naturally that introducing organic materials together with mineral fertilizings had positively affected on the vital activity of the given group of microorganisms. And it stimulated significantly to their propagations, less intensively was the development process of microorganisms in the variants with introducing only mineral fertilizings. The least number of nitrogen-fixers was noted in the monitoring, it was composing 11.5x10^6/gr of soil in July.

In autumn (September), when the irrigated water had been dumped from the rice beds, hence, relative anaerobiosis was formed in the soil substratum and the population of anaerobic cellulose-destroying microorganisms in the soil was slightly decreased. However, in the variant Sample+CS^4 +PD (1^{st} dose) the number of

Table 1. The impact of composted straw on the population of soil microorganisms (field experiment of 2007)

No	Experiment variants	Cellulose-destroyings, 10^6/gr of soil			Nitrogen-fixings, 10^6/gr of soil		
		May	July	September	May	July	September
1	Monitoring (without fertilizings)	1.53	11.5	10.2	6.8	25.7	22.4
2	NPK – Sample	2.02	17.4	14.5	7.2	18.4	15.8
3	Sample + CS^4	8.08	65.2	53.4	15.04	88.7	64.9
4	Sample + PD (1^{st} dose)	6.12	53.6	32.5	12.8	75.5	60.5
5	Sample + PD (2^{nd} dose)	7.08	58.7	40.6	8.7	71.2	52.8
6	Sample + CS^4 + PD (1^{st} dose)	15.4	92.04	88.7	21.5	121.8	105.4
7	Sample + CS^4 + PD (2^{nd} dose)	14.32	71.5	64.5	18.4	92.4	73.7
	$LSD_{0.05}$	0.04	0.03	0.03	0.01	0.02	0.02

bacteria was remained relatively high-88.7x10^6 /gr.

The given fact indicates that on introducing mineral fertilizers combined with composted rice straw and poultry droppings, various vegetable residues were better decomposed, as a result of, the soil was more enriched with nutritious substances and active propagations of cellulose-destroying microorganisms were observed, their intensive developments were noted during the whole vegetation of rice.

The cellulose-destroying microorganisms, intensively decomposing vegetable residues, form the products of their decomposition, supplying vital activity of another population and in particular, anaerobic free-living nitrogen-fixers and denitrifying microorganisms [10,11].

On anaerobic decomposition of cellulose many organic acids (acetic, succinic, milk, butyric), ethyl spirit, carbon dioxide and hydrogen are formed. Therefore, anaerobic decomposition of cellulose is accompanied by active development of concomitant microorganisms and frequently, nitrogen-fixing bacteria [12]. The authors noted that the bacteria *Clistridium thermocellum and Eubacterium cellulosolvens* had taken active part in cellulose decomposings.

As it is known, non-symbiotic nitrogen-fixing microorganisms, *Clostridium pasteurianum* take particular place among anaerobic microorganisms in the inundated soil [13].

As it is shown, the population of nitrogen-fixing microorganisms was defined on introducing mineral and organic fertilizings into the soil in many cases. So, in the first year of field experiment it had reached 18.4mln/gr in the variant NPK-Sample in July, whereas with introducing composted straw Sample+CS^4-88.7 mln/gr.

On introducing composted straw into the soil the number of nitrogen-fixers was more than in the variants with introducing mineral fertilizings only. It was remarkable that during the whole vegetation of rice the number of *Clostridium pasteurianum* bacteria in the variants with usage of composted straw was higher than in the variants with usage of poultry droppings only. In autumn, September, the population of anaerobic nitrogen-fixers was decreased since water had been dumped from the rice beds, but it had remained high in the variants Sample+CS^4 + PD (1st dose) and Sample +CS^4 + PD (2nd dose), relatively 105.4x10^6 /gr and 73.7 mln/gr of soil.

Thus, combined introducing of nitrogen and organic fertilizings had activated the development of anaerobic cellulose-destroying and nitrogen-fixing microorganisms.

It is established by researches that the enrichment of the soil by energetic materials (various vegetable residues) makes favorable condition for the growth of nitrogen-fixing activity in tens and hundreds times comparing with monitoring without introducing organic substances [14].

The anaerobic nitrogen-fixing microorganisms of *Clostridiumare* genus were most studied in detail by V.T. Emtsev [15]. Summarizing available results had allowed to conclude that the maximum number of cells *Clostridium* was marked, when there was a great number of a fresh organic substance. Thus, the author noted that the significant part of these microorganisms was in the soil in the state of vegetative cells, that is in their active form.

Next year, for changing of nutritional regime, caused by the usage of composted straw and poultry droppings, cellulositic and nitrogen-fixing bacteria had quickly reacted, that showed the increase of their number comparing with the monitoring approximately 5-10 times (Table 2).

LSD – least significant difference is applied for statistical analysis and shows the deflection of digital data.

It is necessary to suppose, that on introducing various organic materials the meadow-boggy soil were better enriched with nutritious substances, as a result of which a rapid outbreak of anaerobic bacteria was occurred in the spring. It might be also caused by some factors: humidity, temperature and mineralization of organic fertilizings rate - straw and poultry droppings. The increase of population of microorganisms in July and the decrease in September had proved about it.

Table 2. Dynamics of anaerobic microorganisms population on a combined introducing of mineral and organic fertilizings (2008, after-action)

No	Experiment variants	Cellulose-destroyings, $10x^6$/gr of soil			Nitrogen-fixings, $10x^6$/gr of soil		
		May	July	September	May	July	September
1	Monitoring (without fertilizings)	1.37	10.8	9.7	5.4	22.5	18.8
2	NPK – Sample	1.8	15.4	12.3	6.0	24.2	22.5
3	Sample + CS^4	9.35	72.5	67.2	15.8	75.8	70.5
4	Sample + PD (1^{st} dose)	4.8	35.3	24.5	12.4	64.5	58.3
5	Sample + PD (2^{nd} dose)	8.52	53.4	41.8	8.42	62.8	51.8
6	Sample + CS^4 + PD (1^{st} dose)	13.8	88.7	71.5	20.8	124.4	112.9
7	Sample + CS^4 + PD (2^{nd} dose)	9.44	70.5	54.2	17.5	88.7	79.8
	$LSD_{0.05}$	0.02	0.02	0.04	0.01	0.01	0.02

In the second year of field experiment the anaerobic microorganisms population had been increased comparing with the first year, particularly it was noticeable in the variants where mineral fertilizings were introduced combined with organic materials. So, in May Cellulose-destroying microorganisms number was increased 6.8-10.0 times in comparison with the monitoring in the variants Sample+CS^4 and Sample + CS^4 + PD (1^{st} dose). A great number of *Clostridium pasteurianum* was marked as well in the variants Sample + CS^4 + PD (2^{nd} dose)- $9.44x10^6$ cells in 1gr of soil.

It was supposed that the high population of microorganisms was caused by several facts: nutrient materials provision, humidity, soil temperature and mineralization of organic materials rate.

It is obvious, that the first and last factors were most reasonable for soil clostridium activity, as it is known that spore bacteria are able to use substances, accumulating at the latest stages of vegetable residues decomposings [16-17].

A cellulose and hemicellulose were included in the rice straw compound, which were easily undergone to the decomposings by enzyme systems of soil organisms. By this reason, introduced into the researching soil composted straw (more correctly its weakened cellulose components), being melted the first years, had increased the microorganisms population of the given group.

In such a way, we may come to conclusion that since a composted straw had been introduced into the soil, *1,4* -glycosidic linkages were intensively destroyed. And we see, that the intensity of this process was significantly accelerated on combined introducing them with mineral fertilizings and rice soil was better enriched by biogenic elements and a favorable condition for young-growth humus formation was formed.

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