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TABAKAIEVA M.,
DUBOVY V., Doctor of Agricultural Sciences
DUBOVY O., Candidate of Agricultural Sciences
Zhytomyr National Agroecological University
e-mail: merrymariane@gmail.com

PRODUCTIVITY OF WINTER WHEAT DEPENDING ON DOSE OF SEWAGE SLUDGE IN VEGETATION CONDITIONS

The paper proves that one of alternative type of fertilizers can be sewage sludge of treatment plants. This sludge contains significant amounts of organic matter, macro- and microelements, substances stimulating the growth. It is shown that the agrochemical properties of sewage sludge promotes the productivity of winter and spring wheat in the vegetation conditions. Significant increase of spring wheat harvest is received from the dose of 30 t/ha of sewage sludge and of winter wheat - 10 t/ha.
Keywords: *sewage sludge of treatment plants, winter wheat, spring wheat, productivity, soil bath*

Introduction. It is known that fertilizer is a key resource for improving agricultural productivity [1]. To restore the reserves of humus in the soil, as the research and production practice affirms, we should always use organic fertilizer.

Lack of national reserves of mineral and organic fertilizers requires new ways to optimize the conditions of plant nutrition and soil fertility. It makes sense to use local raw materials - non-traditional organic fertilizers that would satisfy the biological requirements of plants and do not violate the natural chain of soil fertility renovation.

These fertilizers are sewage sludge [2, 3, 7] - organic waste of municipal wastewater treatment plants. This sludge contains significant amounts of organic matter, macro-and microelements, substances stimulating the growth, etc. [2]

Thus, the amount of wastewater that enters the sewage sludge treatment facilities in Zhytomyr is from 13.9 to 15.7 million m^3 per year. During its treatment the sludge is produced. It's amount varies from 0.5 to 1 % of the waste water [3] or from 78 to 157 thousand m^3 of sediment. They include heavy metals, the amount of which does not exceed the maximum allowable number (Table 1), and pathogens.

Table 1

Content of heavy metals in the sediment of urban sewage treatment plants, mg/kg [6]

Indicator	Dry sewage sludge
Cd	0,02
Pb	0,066
B	5,5
Zn	11,359
Cu	2,883
Mn	32,4
Co	0,218

The lack of systematic studies on the agro-ecological doses of soil application makes the issue extremely urgent.

The purpose and objectives of the research. In this context , the aim of our research was to study the agroecological efficiency of different doses of sewage sludge as organic fertilizers on crops of Podolyanka winter wheat, Isolde and Myronivchanka spring wheat in the conditions of vegetation experiment.

Materials and methods. Vegetation experiments were conducted in 2012-2013 in terms of soil bath on the basis of Zhytomyr National Agroecological University according to existing methods for experiments in vegetation conditions. Breeds of winter wheat Podolyanka and spring wheat Myronivchanka and Isolde were used. Two years period sludge sewage of treatment plants was dry, powdery, homogeneous, dark gray, odorless and containing organic matter from 41 to 45 %, with slightly acid reaction (pH 5.3 - 6.7); N 0,7 - 1,5%; P_2O_5 0,9-1,4%; K_2O 0.1-0.2 %; humus 10,2-10,4 %.

For this experiment was taken sod-podzolic loamy soil. The arable layer contains alkali-hydrolyzed nitrogen 61.6 mg, mobile phosphorus - 13.8 mg, exchangeable potassium - 110 mg respectively per 1 kg of soil exchangeable sodium - 228 mg per 1 kg of soil pH_{sol} - 7.3.

Scheme of the experiment on winter wheat crops included four options: 1) control - without application of sewage sludge, equivalent to 1 ha brought in option 2 - 1 t/ha sewage sludge 3) 5 t/ha sewage sludge 4) 10 t/ha sewage sludge. In spring wheat crops - six options : 1) control - without making a deposit , 2) 1 t/ha sewage sludge 3) 5 t/ha sewage sludge 4) 10 t/ha sewage sludge, 5) 20 t/ha sewage sludge, 6) 30 t/ha sewage sludge.

Length of bath was 3 m, height 0.5 m, width 1 m above the ground and placed at a height of 0.5 meters land area accounting winter wheat - 0.75 m^2 (330 plants), spring wheat - 0.25 m^2 (100 plants). Sewage sludge contributed directly to the soil before planting winter wheat and spring wheat.

Between variants of fertilization was placed plastic lamina that was set at the entire section in the soil bath. Care included watering of plants and phenological observations. Harvesting was carried out manually in the phase of full ripeness. Wheat quality parameters were determined according to standard methods [4]. Sampling of municipal sewage sludge in wastewater treatment plants platforms of Zhytomyr was performed by conventional methods [8] and determined their agrochemical composition [9]. Evaluation of agrochemical analyses of soil samples is made according to method [5]. Mathematical data processing was performed on a PC using standard software.

Results and discussion. According to the results of the sewage sludge research essentially influence plant productivity. Winter wheat seed Podolyanka which was sown in the soil bath at the optimal timing for the zone Polissya, September 20, 2012 and September 22, 2013 did not overwintered. Taking into account that the conditions of wintering in the soil baths were unfavorable for wintering plants (air temperature in winter dropped to minus 27,9 º C 3.02.2012 till the minus 18,8 º C 23.12.2013), the plants were freezing out, so it dug out in the field and planted in the soil bath with identical to the field conditions density according to options of fertilizing.

Increasing doses of sewage sludge contributed to increasing plant productivity by years of research. More productivity was in 2013 because of favorable weather conditions during the formation and ripening grain. Thus, in terms of 2012-2013 fertilizers contributed to increasing the weight of 1000 winter wheat grains with application of 10 t/ha sewage sludge to 36.0 g in 2012 to 40.4 g in 2013. The data accounting mass of 1000 grains of wheat shows that the use of sewage sludge was less effective in small doses and was 31,2 g, but adding sewage sludge, even this dose is increased allowances compared to controls. Analysis of the obtained data shows that winter wheat productivity significantly varied depending on the dose of fertilizers.

Table 2

Productivity of winter wheat Podolyanka depending on dose entering sewage sludge

Name of the test	Weight of 1000 grains, g		Yield, cwt/ha	
	2012	2013	2012	2013
Control - no fertilizer	32,8±2,8	38,0±3,0	37,7±2,8	34,1±3,0
1 t / ha	31,2±3,0	40,0±3,4	35,7±2,9	38,1±3,6
5 t / ha	31,0±2,7	40,0±3,8	33,4±3,0	40,0±3,9
10 t / ha	36,0±2,9	40,4±2,9	39,4±3,4	42,1±3,8
X	32,8	39,6	36,6	38,6

Thus, using 10 t/ha of sewage sludge positive effect on increasing plant productivity of winter wheat in 2012 to 39.4 cwt/ha, and in 2013 - to 42.1 cwt/ha, while the yield on the control was 34,1-37, 7 cwt/ha.

Application of sewage sludge significantly affect to the productivity of spring wheat plants Isolda and Myronivchanka. Thus, the spring durum wheat Isolde in variants of the experiment with doses from 1 to 30 t/ha of sewage sludge compared to control, characterized by the growth of this index from 9.6 cwt/ha in control to 24.5 cwt/ha in 2012, and from 4.8 to 38.3 cwt/ha in 2013 (Table 3).

Table 3

Productivity of spring wheat Isolde and Myronivchanka depending on dose entering sewage sludge

Name of the test	Weight of 1000 grains, g		Yield, cwt/ha	
	2012	2013	2012	2013
1	2	3	4	5
Isolde				
Control - no fertilizer	16,0±1,2	28,0±2,4	9,6 ± 0,8	4,8 ± 0,4
1 **t/ha**	19,0±1,6	34,0±2,7	11,4 ± 1,1	11,6 ± 1,0
5 **t/ha**	22,0±1,8	40,0±3,5	12,7 ± 1,2	18,7 ± 1,4
1	2	3	4	5
10 **t/ha**	22,0±1,8	42,0±3,1	15,4 ± 1,0	22,5 ± 1,7
20 **t/ha**	25,0±2,3	46,0±3,9	17,9 ± 1,5	31,9 ± 2,2
30 **t/ha**	26,0±2,1	46,0±4,1	24,5 ± 1,4	38,3 ± 2,1
X	21,7	39,3	15,3	21,3
Myronivchanka				
Control - no fertilizer	25,0±2,1	28,0±2,4	4,6 ± 0,4	4,9 ± 0,3
1 **t/ha**	35,0±3,2	32,0±2,9	9,6 ± 0,8	10,8 ± 0,7
5 **t/ha**	35,0±3,1	36,0±3,1	12,8 ± 1,0	12,4 ± 1,1
10 **t/ha**	36,0±3,0	36,0±3,2	17,8 ± 1,1	18,0 ± 1,3
20 **t/ha**	37,0±3,4	40,0±3,6	25,2 ± 2,0	26,3 ± 2,0
30 **t/ha**	37,0±3,3	42,0±3,4	29,0 ± 2,1	32,0 ± 2,1
X	34,2	35,7	16,5	17,4

Productivity of Myronivchanka was in the range of 4.6 cwt/ha in control to 29.0 cwt/ha in variant with 30 t/ha sewage sludge in 2012 and to 4.9 cwt/ha to 32.0 cwt/ha in 2013. The average productivity of Isolde plants was 15.3 cwt/ha in 2012, and 21.3 cwt/ha in 2013 and 16.5 cwt/ha and 17.4 cwt/ha of Myronivchanka

We found a significant difference between the variants of fertilization of spring wheat Isolde. As for variety Myronivchanka, such a difference in doses did not promote increased productivity of plants. This difference, we believe, dictated by the biological characteristics of varieties: spring hard wheat more demanding to growing conditions, requires an adequate level of fertilization and soil moisture, which is not always possible to create in a field conditions, which limits the range of its distribution.

It should be noted that plants of spring durum wheat were characterized by relatively smaller mass of 1000 grains, but were more productive than plants varieties of spring wheat .

Significant increase of mass of 1000 grains is received from the dose of 30 t/ha of sewage sludge. Analyzing the data during two years of experiments we should noted that the highest mass of 1000 grains of spring wheat Isolde was received in 2013, due to providing better wet.

During the years of experiments the average weight of 1000 grains of wheat spring Myronivchanka was 34,2-35,7 cwt/ha, which is 7,7-9,2 cwt/ha more than in the variant without the use of fertilizers.

Conclusions. Thus, the research shows that the introduction of 10 t/ha sewage sludge increase the productivity of winter wheat in the vegetation conditions in all variants. which increased the grain yield of winter wheat in vegetation conditions to 8.0 cwt/ha in comparison with the control.

Application of sewage sludge on spring wheat, even in small doses increased the productivity of plants, but yield significant allowances received from the dose of 30 t/ha.

So, on the basis of previous researches, it should be noted that this sewage sludge can be recommended as an alternative to mineral fertilizers on wheat crops.

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Анотація

Табакаєва М.Г., Дубовий В.І., Дубовий О.В.

Продуктивність пшениці в умовах вегетаційного досліду залежно від дози внесення осаду стічних вод каналізації

Показано, що одним з альтернативних видів добрив може бути осад стічних вод (ОСВ) каналізації, який містить значну кількість органічної речовини, макро- і мікроелементи, рістстимулюючі речовини. Встановлено, що агрохімічні властивості осаду сприяють підвищенню продуктивності рослин пшениці озимої і ярої в умовах вегетаційного досвіду. Істотні надбавки урожаю отримані від дози внесення 30 т/а ОСВ на пшениці ярої і від дози 10 т/га ОСВ – на озимій.

Ключові слова: *осад очисних споруд каналізації, пшениця озима, пшениця яра, продуктивність, ґрунтова ванна*

Аннотация

Табакаева М.Г., Дубовой В.И., Дубовой О.В.

Продуктивность пшеницы в условиях вегетационного опыта в зависимости от дозы внесения осадка сточных вод канализации

Показано, что одним из альтернативных видов удобрений может быть осадок сточных вод (ОСВ) канализации, который содержит значительное количество органического вещества, макро- и микроэлементов, ростстимулирующих веществ. Установлено, что агрохимические свойства осадка способствуют повышению продуктивности растений пшеницы озимой и ярой в условиях вегетационного опыта. Существенные надбавки урожая получены от внесения дозы 30 т/га ОСВ на пшенице ярой и от дозы 10 т/га ОСВ – на озимой.

Ключевые слова: *осадок сточных вод канализации, пшеница озимая, пшеница ярая, продуктивность, почвенная ванна*