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CROP PRODUCTION

SOYBEANS ON THE ANTHROPOGENICALLY TRANSFORMED PEAT SOILS OF BELARUSIAN POLESYE

Conflict of Interest

None declared.

Luchanok L.*

Republican Scientific branch unitary daughter enterprise "Institute for Land Reclamation", 153 M. Bogdanovicha str., 220040, Minsk, Belarus

*To whom correspondence should be addressed.

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Abstract

The article presents data on soybean yields in anthropogenically transformed peat soils of Polesye region. It is established that it can generate up to 4.0 t̄/ha and dry matter up to 11.3 t/ha. Yield level is determined by the varietal characteristics, the degree of drawdown of the peat soil and agricultural technology complex. Biologically active substances (BAS) can be used for presowing treatment of seeds and its performance is not inferior biological preparations based on symbiotic bacteria. On average, the treatment options seeds BAS grain yield obtained is higher compared to the variants of pre-sowing seed inoculation with biopreparations based on symbiotic microorganisms. During the pre-sowing seed treatment with BAS on the background of the introduction of phosphorus-potassium fertilizer obtained yields were comparable with variants of nitrogen fertilizer: 2.16 t/ha ($P_{40}K_{75}$) and 2.52 t/ha ($P_{80}K_{150}$) vs 2.15 t/ha ($N_{30+10}P_{40}K_{75}$) and 2.41 t/ha ($N_{30+10}P_{80}K_{150}$), respectively. High efficiency was shown by water-soluble granular complex fertilizer ADOB Profit applied as foliar sprays. Grain yield on the options as in the pre-sowing seed inoculation with biopreparations and biologically active substances, was at 2.30-2.79 t/ha. the Use of biologically active substances for pre-sowing seed treatment or foliar feeding, as well as ADOBE Profit allows to reduce the use of nitrogen fertilizers, and minimize the mineralization of organic matter of peat soils.

Keywords: *soybean, anthropogenically transformed peat soils, yield, grain, green mass, productivity, agro-economic efficiency, Polesie*

Contact*: phone: +375172885506, fax: +375172926496, e-mail: l_luchenok@mail.ru*

1. Introduction

In the region of the Belarusian Polesye the main condition for the development of animal husbandry is the creation of a stable fodder base. To solve this problem is of great importance to increase the share of legumes in the crop pattern. However, the establishment of perennial swards with legumes, particular attention should be paid to annual leguminous crops, of particular interest among which is soybean. This culture contains the highest amount of protein among legumes (36-44 %), has a balanced essential amino acids in grain digestibility is a valuable source of vegetable fat (19-22 %) [1]. Soybean is widely cultivated in Ukraine and Russia, where it is successfully grown even in the Pskov region [2-5].

Currently, the developed technology of cultivation of soybean [6], recommended for mineral soils of the Republic of Belarus. The peat soils of different stages of the transformation are considered to be unsuitable for effective cultivation. However, such varieties of soil in the process of long agricultural use has acquired a number suitable for cultivation of this crop properties (compacted, reduced the content of organic matter (OM), there is an overabundance of soil nitrogen, moisture, etc.). In addition, currently in the region of Polesye favorable climatic conditions for the cultivation of this valuable fodder culture. Over the last decade was an increase in the sum of active temperatures of 100-250 ˚C that allows guaranteed to cultivate early- and mid-season soybean varieties. Thus, there are all prerequisites for expansion of area under this crop, which can take a leading position among the cultivated in this region of the bean plants.

The purpose of this research was to determine possibilities of cultivating soybeans on anthropogenically transformed soils of Belarus, the definition of the range of possible yields and productivity in these terms as well as the establishment of a complex of the most effective agrobiotechnologies techniques.

2. The methodology and conditions of research

To develop agrobiotechnologies methods of cultivation of soybeans to effectively adapt the technology to anthropogenically transformed peat soils were laid out field experiments at the Polissya experimental station of ameliorative agriculture and grassland farming (Passel Luninets district, Brest region) with OM ~5 % (mineral post- and residual-peat) and OM ~25 % (peat-mineral) from a depth of 25-30 and 35-45 cm, respectively underlain by sand. Agrochemical parameters:

plot I with OM ~5 %: pH_{KCl} ~5.8; the contents of mobile forms (in 0.2 M HCl) P_2O_5 ~ 200 mg/kg of soil, K_2O ~ 290 mg/kg soil, CuO ~1.2 and ZnO ~4.6 mg/kg of soil

plot II with OM ~25 %: pH_{KCl} ~5.6; mobile forms of P_2O_5 ~300 and K_2O ~400, CuO ~5.6 and ZnO ~8.1 mg/kg soil.

The studies were carried out conformity assessment of available soil and hydrological conditions, biological characteristics of soybean.

For the development of effective and demanded technologies of soybean cultivation was studied the ways of pre-sowing seed treatment, including biologics and biologically active substances, the use of various tank mixtures for foliar feeding. In the experiments as the base technology used is recommended for soybean cultivation on automorphic mineral soils. Pre-sowing seed treatment carried out in 2010-2011 biologic Soyariz derived from bacteria *Bradyrhizobium japonicum* (developed by SSI "Institute Microbiology of Belarus NAS"), in 2014-2015 the commercial drug Noctin-A (strain *Bradyrhizobium japonicum E109*). As biologically active substances used the drug Ecosil (BAS, made in Belarus), which includes a complex of triterpene acids.

Laboratory-vegetative experiment to assess the effect of seed treatment with drugs Noctin and Ecosil and the background of mineral nutrition on the development of soybean plants at early stages of ontogenesis. Options experience: $N_0P_0K_0$, $P_{40}K_{75}$, $P_{40}K_{75}$ + $(BAS)_{\text{in the phase 1 sheet}}$, $N_{30}P_{40}K_{75}$, $P_{40}K_{75}$ + $(N_{20}$ + $BAS)_{\text{in phase 1 sheet}}$ of the worksheet. In the experiment evaluated the influence of various methods of presowing treatment of seeds, amount of fertilizers and foliar treatment of plants on a morphological parameter of soybean plants: plant height, length and weight of roots.

Field experiments evaluated the influence of a similar agrobiotechnologies methods on grain yield and green mass of soybean.

In 2011-2012, on plot I cultivated soybean varieties Yaselda: middle - $\sum act.\ t$ = 2250 °C, the plant height is 60-80 cm, the proportion of beans, located at the height up to 15 cm – 4 %, seeding rate – 0.8 million viable seeds/ha, drill.

Options experience:

- basic technology: inoculation of seeds bacterial drug Soyariz + $Mo_{(150\text{ g/ha rate of seeds})}$, dose – $N_0P_0K_0$, $N_{30+10+10}P_{60}K_{80}$, $N_{30+10+10}P_{60}K_{80}$ (aftereffect of manure). In phase 1-3 of the worksheet, the chemical weeding of herbicide Pivot (0.9 l/ha);
- developed technology 1: the inoculation of seeds bacterial drug Soyariz and $Mo_{(150\text{ g/ha rate of seeds})}$, dose – $N_0P_0K_0$, $N_{30+10+10}P_{60}K_{80}$, $N_{30+10+10}P_{60}K_{80}$ (aftereffect of manure). In phase 1-3 of the worksheet used foliar feeding tank mixtures (N_{10}, trace element $Mo_{0.02}$, BAS Pulsar (0.5 l/ha), Pivot (0.4 l/ha)), in the phase of budding-beginning of flowering – N_{10}, trace elements mix (TE): $B_{0.05\text{ g/ha}}$ + $Cu_{0.035\text{ g/ha}}$ + $Zn_{0.04\text{ g/ha}}$ + BAS;
- developed technology 2: the inoculation of seeds BAS and $Mo_{(150\text{ g/ha rate of seeds})}$, dose – $N_0P_0K_0$, $N_{30+10+10}P_{60}K_{80}$, $N_{30+10+10}P_{60}K_{80}$ (aftereffect of manure). In phase 1-3 of the worksheet used foliar feeding tank mixtures (N_{10}, trace element $Mo_{0.02}$, BAS Pulsar (0.5 l/ha), Pivot (0.4 l/ha)), in the phase of budding-beginning of flowering – N_{10}, trace elements mix: $B_{0.05\text{ g/ha}}$ + $Cu_{0.035\text{ g/ha}}$ + $Zn_{0.04\text{ g/ha}}$ + BAS.

In 2014-2015, plot II was cultivated soybean varieties Orissa: early maturing, $\sum act.\ t$ = 2100 °C, plant height 80-105 cm, the proportion of beans, located at the height up to 15 cm – 3 %, the seeding rate is 0.65 million viable seeds/ha, drill.

Options experience: $N_0P_0K_0$, $P_{40}K_{75}$, $P_{80}K_{150}$, $P_{40}K_{75}$ $BAS_{1\text{-}3\text{ sheet}}$ + $(TE + BAS)_{bud}$, $P_{80}K_{150}$ $БАВ_{1\text{-}3\text{ sheet}}$ + $(TE + BAS)_{bud}$, $N_{30}P_{40}K_{75}$ + $N_{10(bud)}$ (the underlying technology), $N_{30}P_{80}K_{150}$ + $N_{10(bud)}$, $P_{40}K_{75}$ + $(N_{20}$ +$BAS)_{1\text{-}3\text{ sheet}}$ + $(N_{20}$ + TE + $BAS)_{bud}$, $P_{80}K_{150}$ + $(N_{20}$ + $BAS)_{1\text{-}3\text{ sheet}}$ + $(N_{20}$ + TE + $BAS)_{bud}$, $P_{40}K_{67}$ $(N_{20}$ + $BAS)_{1\text{-}3\text{ sheet}}$ + ADOB $Profit_{bud}$, K_{134} + ADOBE-$Profit_{1\text{-}3\text{ sheet}}$ + ADOBE $Profit_{bud}$

Before sowing seeds were treated with commercial biopesticide Noctin-A with $Mo_{50\text{ g/ha rate of seeds}}$ or a solution of BAS with $Mo_{50\text{ g/ha rate of seeds}}$.

The plant protection carried out the background: before emergence – Pivot (a.s. imazethapyr), 10% V. K., 1 l/ha, in phase 1-3 leaves – Pulsar (a.s. imazamox). SL, BP, 0.8 l/ha Basagran (a.s. bentazone), 2.0 l/ha or in tank mixture with BAS and nitrogen. ADOBE Profit – water-soluble granular fertilizer N : P : K (10 : 40 : 8) the trace elements complex.

Yields were calculated taking into account losses at harvest.

Weather conditions during varied by years. In 2011, the water regime at the plot I was adverse. The lack of rainfall (20 mm rainfall in the month of may) has led to the fact that in the layer 0-40 cm soil moisture was at a level of humidity sustainable wilting plants. Even when July and August precipitation groundwater level (GWL) remained at a depth of 140-170 cm.

The spring of 2012, favorable water and temperature conditions. So in April fell more than 2 the amount of precipitation that compensate for their deficit in previous months. In may fell to 51.4 mm (3.1 mm below normal). The temperature in this period was warmer compared to the long-term average, which contributed to the growth and development of soybean plants. And even frosts to -7 – 10 °C from 2 to 3 June caused damage to the crops. However, the dry period from 28.06.2012 to 18.07.2012 led to a sharp deterioration of the water regime. Low levels of GWL (146-176 cm) on the background of relatively high average July temperature (above long-term average by 3 °C) influenced the formation of grain yield.

Weather conditions of vegetation periods 2014-2015 were generally characterized by higher than average long-term values of average monthly air temperatures. However, in the spring of 2014 and 2015 are marked by sudden changes in day and night temperatures. Throughout April and may 2015 in the region of Polesye was celebrated the night frosts down to minus 6 °C in April to -7 in early may. Thus, the average minimum temperature at a height of 2 cm in these months is -1.8 and 3.4 °C, and day – of 14.3 and 19.8, respectively. Night temperature of June was at the level of 5.8 °C, Jul to 9.2 °C, Aug -7.4 at day – 24.1, 25.5 and 29.1 °C, respectively. In 2015 the GWL was at around 100 cm in the second decade of April and decreased to 140-150 cm in July-August. While in 2014, GWL only in the dry period dropped to 125-130 cm, and the average for the season was in the range of 100-115 cm, weather conditions 2014-2015 were unfavorable for the growth and development of such warm-weather crops like soya, and 2015 can be more arid.

3. Research results and discussion

The objective of the experiment, conducted in 2011-2012, was to assess the possibility of cultivation of soybean highly mineralization peat soils, which by their agrochemical characteristics and properties are not inferior to automorphic sandy and sandy loam, underlain by sand, is widely distributed in the region of Polesye. In addition, the possibility of seeking alternatives to biological products based on culture of live microorganisms used for pre-seed inoculation (with certain storage conditions and processing), as a more affordable and effective biologically active substances. Using the proposed technique will allow to simplify and make more accessible to the production technology of soybean cultivation. Due to the fact that all peat soils depleted in trace elements, in the experiment also evaluated the efficacy of foliar feeding soybeans with micronutrients.

On a plot of I c mineral post- and residual-peat soils (OM ~5 %) grain yield of soybean was, on average, low – 0.5-1.33 t/ha and depended on weather conditions of vegetation period and agrobiotechnological method (table. 1).

Weather conditions of growing seasons allowed the class to realize its potential only 23-26 % (grade Yaselda requires more moisture). This is mainly due to the fact that the phase of flowering, setting and ripening of beans (the most sensitive to moisture) falls on the most arid region in the periods – the second half of July-August.

In the experiment, it was found that in 2011 (dry spring) the biological product Solaris was more effective than BAS. The yield on a comparable variants with application of foliar feeding TE, differed by 1.4-1.5 times. The most effective this year was the fundamental technology that ensured the grain yield of soybean in the variants with fertilizer 0.71-0.94 t/ha. In options aftereffect of manure grain yield was lower (at the control level) compared with applications in crop rotation, the mineral fertilization system (tab. 1).

In 2012, when the dry period fell on July-August, soybean yields were higher compared to 2011 In the basic technology of it has reached the level of 0.68 to 0.77 t/ha, with technology 1 – 0.73-0.79 t/ha, and with presowing seed treatment with BAS (technology 2) yield increased to 1.08 and 1.33 t/ha (table. 1). Thus, it is possible to make preliminary conclusion that pre-sowing seed treatment with BAS under favorable weather conditions, already in the early stages of ontogenesis stimulates the growth and development of plants, which increases their invariance to adverse effects, such as drought observed in the summer months.

Table 1 – Effect agrobiotechnologies techniques on yield of soybean (OM~ 5 %)

Option	Yield, t/ha			Productivity**, t feed unit/ha		
	2011	2012	average	2011	2012	average
the underlying technology (inoculation of seed Soyariz + $Mo_{(150\ g/ha\ rate\ of\ seeds)}$)						
$N_0P_0K_0$	0.58	0.90	0.74	0.87	1.39	1.13
$N_{30}P_{60}K_{80}+N_{20}$	0.94	0.68	0.81	1.39	1.03	1.21
$N_{30}P_{60}K_{80}*+N_{20}$	0.71	0.77	0.73	1.08	1.16	1.12
researched technology 1 (inoculation of seed Soyariz + $Mo_{(150\ g/ha\ rate\ of\ seeds)}$)						
$N_0P_0K_0$	0.77	0.85	0.81	1.17	1.30	1.24
$N_{30}P_{60}K_{80}$+(N_{10}+TE+ BAS)+(N_{10}+ TE+BAS)	0.81	0.79	0.80	1.24	1.23	1.24
$N_{30}P_{60}K_{80}$*+(N_{10}+TE+BAS)+(N_{10}+ TE +BAS)	0.50	0.73	0.62	0.76	1.12	0.94
researched technology 2 (inoculation of seeds BAS + $Mo_{(150\ g/ha\ rate\ of\ seeds)}$)						
$N_0P_0K_0$	0.52	0.92	0.72	0.79	1.41	1.10
$N_{30}P_{60}K_{80}$+(N_{10}+TE+BAS)+(N_{10}+TE+BAS)	0.59	1.08	0.84	0.90	1.64	1.27
$N_{30}P_{60}K_{80}$*+(N_{10}+TE+BAS)+(N_{10}+TE+BAS)	0.59	1.33	0.96	0.88	2.06	1.47
least significant $difference_{05}$	0.06	0.14		0.11	0.25	

Notes: * options aftereffect of cattle manure to be made under the corn; ** productivity was calculated for each variant based on biochemical parameters

Noted the high level of soybean yield in the variants without fertilization. This is due to the fact that even highly mineralized peat soil in early spring have a relatively high mineral nitrogen up to 50 kg/ha [6] and with the available level of mobile forms of phosphorus and potassium is capable of forming up to 0.90 to 0.92 t grain/ha application of mineral fertilizers only in some cases gave a reliable increase productivity. Thus, first experiments showed that soybean cultivation requires selection of favourable soil and hydrological conditions.

With this purpose in 2014-2015, were laid a number of experiments on different soil varieties with a high content of OM (~25 %) and the average seasonal groundwater table 100-115 cm to 150 cm in the dry period.

To determine the effect of biopreparations and BAS on the growth and development of soybean plants was carried out on a laboratory-vegetation on different backgrounds of mineral nutrition, which found that by taking pre-treatment of seeds already in the early stages of ontogenesis, you can control the growth and development of plants. So, in phase first of trifoliate leaf observed that the plants whose seeds are processed BAS, developed better. Root weight and plant height were higher in comparison with plants whose seeds were treated with biologics. Further to the stage of four true leaves, this effect is amplified. It should be noted that the use of biologically active substances for inoculation of seeds contributed to the development of the root system. It was noted that in the early stages of plant growth the most effective option for fertilization was the variant with pre-sowing making N_{30} amid $P_{40}K_{75}$ (table. 2).

Obtained in laboratory conditions dependences were confirmed in field experiments. Presowing treatment of seeds of BAS increased aboveground and root mass. Examination of soybean plants in laboratory and field experiments revealed that root system from the early stages of ontogenesis to the phase of budding is not observed the formation of nodules (except for plants in the control, having 1-2 of the nodule). These features should be considered when selecting the optimal agrobiotechnologies techniques [7].

Table 2 – Influence of method of presowing treatment of seeds and fertilizer doses on the development of soybean plants at early stages of ontogenesis

Option	Phase of development of soybean plants					
	first true sheet			fourth true leaves		
	Noctin-A	BAS	преимущество BAS / Noctin-A, %	Noctin-A	BAS	Advantage BAS / Noctin-A, %
height of plants, cm						
$N_0P_0K_0$	14.0	14.0	0	42.5	67.0	57.6
$P_{40}K_{75}$	13.3	17.0	27.5	39.5	45.0	13.9
$P_{40}K_{75}$+(BAS) $_{1\ sheet}$	-	-	-	51.0	55.0	7.8
$N_{30}P_{40}K_{75}$	16.0	15.0	-6.3	34.0	78.0	129.4
$P_{40}K_{75}$+(N_{20}+ BAS) $_{1\ sheet}$	-	-	-	43.0	48.0	11.6
K_{134}+ ADOBE Profit $_{1\ sheet}$	11.0	15.0	36.4	45.0	46.0	2.2
least significant difference$_{05}$	0.9	0.6		1.9	2.7	

End of Table 2

Option	Phase of development of soybean plants					
	first true sheet			fourth true leaves		
	Noctin-A	BAS	преимущество BAS / Noctin-A, %	Noctin-A	BAS	Advantage BAS / Noctin-A, %
length of roots, cm						
$N_0P_0K_0$	16.7	11.0	-34.1	24.3	22.5	-7.2
$P_{40}K_{75}$	18.4	18.6	1.1	21.8	23.3	6.9
$P_{40}K_{75}$+(BAS) $_{1\ sheet}$	-	-	-	22.5	21.8	-3.3
$N_{30}P_{40}K_{75}$	20.0	24.0	20.0	21.3	40.4	90.1
$P_{40}K_{75}$+(N_{20}+ BAS) $_{1\ sheet}$	-	-	-	26.5	18.0	-32.1
K_{134}+ ADOBE Profit $_{1\ sheet}$	23.0	20.0	-3.0	26.0	22.5	-13.5
least significant difference$_{05}$	0.9	0.8		1.1	1.2	
the mass of roots, g/plant						
$N_0P_0K_0$	0.09	0.13	44.4	0.16	0.20	25.0
$P_{40}K_{75}$	0.09	0.14	51.9	0.16	0.23	43.8
$P_{40}K_{75}$+(BAS) $_{1\ sheet}$	-	-	-	0.14	0.22	57.1
$N_{30}P_{40}K_{75}$	0.13	0.14	7.7	0.11	0.35	218.2
$P_{40}K_{75}$+(N_{20}+ BAS) $_{1\ sheet}$	-	-	-	0.19	0.18	-5.3
K_{134}+ ADOBE Profit $_{1\ sheet}$	0.22	0.24	9.1	0.24	0.25	4.2
least significant difference$_{05}$	0.005	0.005		0.008	0.01	

Soy is cultivated not only grain, but also on the green mass. In this case, culture may be used as insurance, sowing in June or a few times a year. During field experiments it was determined that the yield of dry matter can reach 8.0-11.0 t/ha depending on weather conditions and agrobiotechnologies techniques (tab. 3).

In 2015, weather conditions contributed to the accumulation of plant above-ground mass, but was negatively affected on grain yield, which is associated with dry period during flowering and ripening of beans. The average yield of green mass for option presowing treatment of seeds by a biological product in 2015 was higher by 3.69 t/ha compared with the 2014 Best in the studied years was the basic option of making $N_{30}P_{40}K_{75}$ + $N_{10(bud)}$ on which the yield was 8.88 t/ha, 9.85 and 9.37 t/ha dry mass in 2014, 2015 and average over the 2 years, respectively. Also note the options for making $P_{80}K_{150}$ (dose calculated based on the removal), K_{134} + ADOBE Profit in 2 phases, which yields in 2014, 8.54 and 7.40 t/ha, in 2015 – and 9.54 and 10.80 t/ha, and the average for 2 years – and 9.04 and 9.10 t/ha. In all other cases, although the yield varied by years in the 1.4-2.4 times depending on the reception, but on average for 2 years was in the range of 7.7-8.7 t dry matter per ha.

In a variant of pre-sowing seed treatment of BAS, the yield of dry matter per year and per variants are more stable than with seed inoculation with biological product. In 2015, it is only 1.1 to 1.4 times higher compared with 2014 Exception of ways of making $P_{40}K_{75}$ and $P_{80}K_{150}$, which in 2015 yields decreased 1.2-1.3 times. On average for 2 years the best options were $P_{40}K_{75}$, $P_{80}K_{150}$ and $N_{30}P_{40}K_{75}$ + $N_{10(bud)}$, on which the yield of dry matter was 8.41-9.33 t/ha (table 3).

Experiments have shown that anthropogenically transformed peat soils OM ~25 % soya can generate grain yield in the range of 1.20 to 4.38 t/ha, depending on agrobiotechnological reception and weather conditions. Due to soil fertility at the level of 1.12-2.84 t/ha. Grain yield in the 2014 higher and reached an average of 2.29-3.03 t/ha, and in 2015 below is 1.51 and 1.82 t/ha.

Table 3 – Effect agrobiotechnologies techniques on yield of soybean (OM ~25 %)

Option	Yield, t/ha					
	dry weight			grain		
	2014	2015	average	2014	2015	average
presowing treatment of seeds preparation Noctin-A						
$N_0P_0K_0$	2.85	7.31	5.08	1.35	1.91	1.63
$P_{40}K_{75}$	4.10	10.03	7.07	1.43	1.47	1.45
$P_{80}K_{150}$	8.54	9.54	9.04	1.99	1.68	1.83
$P_{40}K_{75}$ + BAS $_{1\text{-}3\ sheet}$ + $(TE + BAS)_{bud}$	5.12	10.19	7.66	2.06	1.78	1.92
$P_{80}K_{150}$ + BAS $_{1\text{-}3\ sheet}$ + $(TE + BAS)_{bud}$	5.01	11.27	8.14	2.01	1.78	1.89
$N_{30}P_{40}K_{75} + N_{10(bud)}$	8.88	9.85	9.37	2.96	2.14	2.55
$N_{30}P_{80}K_{150} + N_{10(bud)}$	7.17	10.23	8.70	3.09	1.49	2.29
$P_{40}K_{75} + (N_{20} + BAS)_{1\text{-}3\ sheet} + (N_{20}$+ TE + $BAS)_{bud}$	6.95	9.78	8.36	3.21	1.57	2.39
$P_{80}K_{150} + (N_{20} + BAS)_{1\text{-}3\ sheet} + (N_{20}$+ МЭ + $BAS)_{bud}$	6.15	10.06	8.10	2.46	1.58	2.02
$P_{40}K_{67} + (N_{20}$+ $BAS)_{1\text{-}3\ sheet}$ + ADOBE $Profit_{(bud)}$	6.38	10.06	8.22	2.29	2.37	2.33
K_{134} + ADOBE Profit $_{(1\text{-}3\ sheet)}$ + ADOBE $Profit_{(bud)}$	7.40	10.80	9.10	2.34	2.25	2.30
Average option	*6.23*	*9.92*	*8.08*	*2.29*	*1.82*	*2.06*
least significant $difference_{05}$	0.58	0.94		0.15	0.10	
presowing treatment of seeds preparation of BAS						
$N_0P_0K_0$	6.24	6.57	6.40	2.84	1.12	1.98
$P_{40}K_{75}$	10.02	7.78	8.90	2.66	1.66	2.16
$P_{80}K_{150}$	10.36	8.30	9.33	3.07	1.97	2.52
$P_{40}K_{75}$ + BAS $_{1\text{-}3\ sheet}$ + $(TE + BAS)_{bud}$	5.68	7.88	6.78	2.52	1.57	2.05
$P_{80}K_{150}$ + BAS $_{1\text{-}3\ sheet}$ + $(TE + BAS)_{bud}$	6.13	8.64	7.38	2.76	2.00	2.38
$N_{30}P_{40}K_{75} + N_{10(bud)}$	8.35	8.46	8.41	2.86	1.43	2.15
$N_{30}P_{80}K_{150} + N_{10(bud)}$	7.80	8.49	8.14	3.14	1.67	2.41
$P_{40}K_{75} + (N_{20} + BAS)_{1\text{-}3\ sheet} + (N_{20}$+ TE + $BAS)_{bud}$	7.24	8.47	7.86	3.11	1.26	2.19
$P_{80}K_{150} + (N_{20} + BAS)_{1\text{-}3\ sheet} + (N_{20}$+ МЭ + $BAS)_{bud}$	5.57	7.89	6.73	2.68	1.35	2.01
$P_{40}K_{67} + (N_{20}$+ $BAS)_{1\text{-}3\ sheet}$ + ADOBE $Profit_{(bud)}$	6.24	8.10	7.17	3.28	1.42	2.35
K_{134} + ADOBE Profit $_{(1\text{-}3\ sheet)}$ + ADOBE $Profit_{(bud)}$	7.35	8.10	7.73	4.38	1.20	2.79
Average option	*7.36*	*8.06*	*7.71*	*3.03*	*1.51*	*2.27*
least significant $difference_{05}$	0.69	0.67		0.21	0.07	

End of Table 3

On average over 2 years of research on all options yield when the seed treatment with BAS was 0.21 t/ha higher than with the reception of seed inoculation with biological product (table 3). However, for years it was formed in different ways. So, in 2014 yield of 0.74 t/ha was higher, and in 2015 was 0.31 t/ha lower in the variants with seeds treatment BAS compared with the inoculation of a biological preparation. The best options during the pre-sowing seed treatment with BAS was: $P_{80}K_{150}$, $P_{80}K_{150}$ + (BAS + TE); $N_{30+10}P_{80}K_{150}$; $P_{40}K_{67} + (N_{20} + BAS)$ + ADOBE Profit; K_{134} + ADOBE Profit (in phase 2). Accordingly, the average for years of research was formed of 2.52; 2.38; 2.41; 2.35; 2.79 t/ha (table 3).

When pre-sowing inoculation of seeds with biological preparation were most effective options:$N_{30+10}P_{40}K_{75}$; $N_{30+10}P_{80}K_{150}$; $P_{40}K_{75}$ + (N_{40} + BAS + TE); $P_{40}K_{67} + (N_{20} + BAS)$ + ADOBE Profit; K_{134} + ADOBE Profit (in phase 2). Consequently, the average 2-year yield was – 2.55; 2.29; 2.39; 2.33; 2.30 t/ha (table 3).

In the variants with presowing seed treatment with BAS a greater number of techniques you can use by farmers in the cultivation of soy. For example, through the use of BAS it is possible to reduce application of nitrogen fertilizers on anthropogenically transformed peat soils. So, even in the embodiment of preplant application of phosphorus-potassium fertilizer obtained 3.47-4.02 t of fodder units/ha. Effective options with foliar feeding of plants with mineral nitrogen together with BAS and me in the background making $P_{40}K_{75}$ and $P_{80}K_{150}$, which received 3.30-3.83 ton of fodder units/ha. Effectively making $N_{30}P_{40}K_{75}$ + $N_{10(bud)}$, producing of 3.48 ton of fodder units/ha.

Also economically viable options for making a soluble complex fertilizers ADOB Profit, which received 3.79-4.48 t of fodder units/ha.

4. Conclusion

Thus, studies on the cultivation of soy in anthropogenically transformed peat soils the possibility of effective cultivation with the level of grain yield up to 4.0

t/ha and dry matter up to 11.3 t/ha. This level is determined by the varietal characteristics, the degree of drawdown of the peat soil and agricultural technology complex.

It is established that biologically active substances, in particular Ecosil can be used for presowing treatment of seeds and its performance is not inferior biological preparations based on symbiotic bacteria. The average for the variants with seeds treatment of BAS, the yield of grain obtained higher compared to the variants of pre-sowing seed inoculation with biopreparations (Soyariz, Noctin-A).

The use of biologically active substances as pre-sowing seed treatment or foliar feeding allows you to reduce the use of nitrogen fertilizers or apply them vegetating plants, which minimizes the mineralization of organic matter of peat soils. So, when the seed treatment with BAS on the background of the introduction of phosphorus-potassium fertilizer obtained yields were comparable with variants of nitrogen fertilizer: 2.16 t/ha ($P_{40}K_{75}$) and 2.52 t/ha ($P_{80}K_{150}$) vs 2.15 t/ha ($N_{30+10}P_{40}K_{75}$) and 2.41 t/ha ($N_{30+10}P_{80}K_{150}$), respectively. Foliar fertilizing BAS with TE also obtained comparable yields of grain.

High efficiency was shown by water-soluble granular complex fertilizer ADOB Profit applied as foliar sprays. Grain yield in these embodiments, as in the pre-sowing seed inoculation with biopreparations and biologically active substances, was at 2.30-2.79 t/ha.

Soy on anthropogenically transformed peat soils and can be cultivated for green mass with a yield of 11.27 t dry matter/ha.

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