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The Influence of Biogumus on the Quality of Cucumber Plants and the Properties of the Nutrient Environment

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ABSTRACT

The present study shows the importance of vermicompost when growing cucumbers in greenhouse conditions. In particular, it was noted that biohumus is significantly superior to traditional components widely used in seedling cultivation in terms of the amount of nutrients and other indicators. In the course of the research, the results of an agrochemical analysis of the initial soil mixture, the composition of manure and biohumus for the main nutrients before the start of the experiment were obtained: an average three-year increase in nutrients in the substrate (soil-wood shavings) indicators was revealed. The pH value is 7.08, the density of the mixture is 0.43 g/cm^3. The smallest amount of nutrients (NPK) in mixtures by options (N-83.8 mg/l, NH_4-9.9 mg/l, NO_3-73.8 mg/l, P_2O_5-11.7 mg/l, K_2O- 122.9 mg/l, MgO -21.8 mg/l, CaO-57.3 mg/l.) NH_4-73.5 mg/l, NO_3-532.6 mg/l). l, P_2O_5-61.3 mg/l, K_2O-773.5 mg/l, MgO-84.7 mg/l, CaO-126.0 mg/l.) corresponds to the variant using 100% biohumus. The ratio of nutrients in this option is N-7.2, NH_4 -7.4, NO_3-7.2, P_2O_5 -5.2, respectively; K_2O-6.3, MgO-3.9, CaO-2.2 were equal. According to different options, a change in the average density of the substrate in 2019-2021 was established. within 0.21-0.50 g/cm^3, depending on the amount of applied biohumus. It shows that changing the amount of vermicompost in the substrate does not significantly affect the pH of the substrate. Nutrients in the 10th variant with a biohumus content of 90% are more than the number of nutrients in the 5th variant (40% biohumus content): nitrogen-2.13, phosphorus-1.96, potassium-2.06, magnesium-1.82 and Ca-1.45 times higher. A low rate for nitrogen was observed in the second year of the experiment, and for phosphorus and magnesium in the first year of the experiment. The highest level of potassium and calcium corresponded to the 3rd year of the experience (2021). It is noted that the values of these elements, determined by the composition of the substrate in the 1st-2nd years of the experiment, do not differ sharply from each other. According to the results of agrochemical analysis, the amount of nutrients in the substrate reaches optimal values in initial mixtures containing 30-50% biohumus. Thus, the dynamics of changes in the amount of nitrogen in the substrate when growing cucumber seedlings corresponds to a change in the amount of vermicompost in the mixture, the amount of vermicompost up to 50%, total nitrogen in the mobile form and its N-NH_4, which is consumed at later stages of plant development, and the amount of N forms. -NO_3 increases. In the following concentrations of vermicompost, the amount of useful nitrogen decreases with an increase in the next time from the day of sowing. The value of the total consumption of phosphorus and potassium in the substrate, corresponding to the period of full development of seedlings, is in the range of 8.0-14.7 mg/l for phosphorus and 45.0-136.1 mg/l for potassium. observed. The use of vermicompost when growing cucumber seedlings stabilizes the agrochemical parameters of the soil in greenhouse conditions, reduces the seedling maturation period, and increases the plant's resistance to fungal diseases. The influence of the amount of heavy metals in the mixture used for growing biohumus was also studied. In the control variant, prepared from a mixture of soil and wood chips in a 1:1 ratio with the use of mineral fertilizers, the mixture containing lead (6.11 mg/kg) and zinc (23.00 mg/kg) appears to be slightly contaminated. The soil is rich in cadmium (0.30 mg/kg) and copper (2.96 mg/kg) and poor in cobalt (0.50 mg/kg) and nickel (0.87 mg/kg), which corresponds to the gradation with average values.

Keywords

Organic agriculture, cucumber, biohumus, heavy metals, gray earth, wood chips

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Introduction

The preparation of seedlings is an important element in the technology of growing cucumbers in greenhouse conditions, and the yield directly depends on the quality of the seedlings (Nagajyoti *et al.,* 2010). Currently, all farms are mainly adapted to growing seedlings in local conditions (Yruela, 2005).

Therefore, the development of the quantity and application scheme of new fertilizers used in growing seedlings for different regions is a necessary part of advanced technologies. In the greenhouses of Uzbekistan, a mixture of gray earth, wood chips (sawdust) and manure (substrate) with good moisture retention and high air permeability is widely used.

In the greenhouse conditions of the Kashkadarya region, the substrate consists of these components, and its composition (the amount of nutrients and pH) is optimized taking into account the requirements of the grown product.

It is known that the cucumber seedling has relatively weakly developed veins, adapted to obtain the necessary nutrients from the soil rich in organic fertilizers. For this reason, growing cucumber seedlings in greenhouses requires nutrient-rich organic fertilizers. Among such organic fertilizers, an important place is occupied by biohumus, rich in humic acids (from 5.6 to 17.6% of dry matter).

In terms of the amount of nutrients and other indicators, vermicompost significantly exceeds the traditional components widely used in growing seedlings.

It should be noted that studies aimed at choosing the optimal substrate parameters for growing cucumber seedlings in a mixture of gray soil and wood shavings using biohumus are not enough. In addition, the effect of biohumus on the agrochemical properties of the substrate and the quality of cucumber seedlings in greenhouse conditions has not been sufficiently studied. Therefore, the development of scientifically based methods for the use of biohumus in the cultivation of seedlings of cucumbers in the conditions of greenhouse farms in our republic is one of the most important urgent tasks.

Materials and Methods

At this stage of the work, the influence of organic fertilizer, biohumus on the agrochemical parameters of the substrate in greenhouse conditions, the growth and development of cucumber seedlings when growing cucumber seedlings "Avicena" F1 in greenhouse conditions were determined.

The studies used the existing technology, widely used in practice, differing in the experimental scheme. In the experiments carried out using this technology, the application of mineral fertilizers to the substrate was carried out two weeks before its laying to the chickens.

The addition of an appropriate amount of vermicompost was done before putting it into the pond. Cucumber seeds were washed in a 1% $KMnO_4$ solution for 1 h in cold running water and then kept in a dilute (1:50 ratio) Na_3PO_4 solution for 1 day. By the time of sowing, most of the germinated seeds were planted in 500 ml pots. Seedlings were planted at a density of 45 seedlings per square meter and covered with a light-transmitting polyethylene film until germination. During germination of seedlings, the temperature was maintained within 25-28°C. As soon as the seedlings began to germinate, the film was removed and the temperature was reduced to 22-24°C. During the first three days, the place where the seedling stood was additionally illuminated (this stage of the technology is necessary in conditions of low solar radiation in winter).

On other days, it was illuminated for 12-16 hours, and the illumination level of the experimental area was 4-5 thousand lux. At night, the air temperature was maintained at the level of 19-20°C. The seedling was transferred to a permanent place in the greenhouse after 30 days.

The quality of cucumber seedlings greatly affects its subsequent productivity. According to the work of Geisler *et al.,* (1979), its indicators before planting should be of average size: height 20-25 cm, number of true leaves 4-5, egg thickness up to 3-5 cm. 5 cm, and total weight up to 20-30 grams. The veins should be white and free from various diseases.

The collected soil samples were mixed thoroughly to form the greenhouse soil average, and thereafter was air-dried, sieved (< 2 mm) and stored in paper bags until analysis. The following parameters of soil chemical properties were subject of analysis: soil reaction (soil pH), content of organic matter (OM), content of available forms of phosphorus (available P) and potassium (available K), and content of total and available forms of Cu, Zn, Mn, and Fe. Soil pH was determined by pH meter in 1:2.5 (v/v) suspensions of soil in water (pH H_2O) and in a 1 M KCl solution (pH KCl) according to ISO 10390 method (ISO, 2005). OM was determined by chromic acid digestion method (Senad Murtić *et al.,* 2019; ISO, 1998), available forms of phosphorus and potassium by ammonium lactate method (Senad Murtić *et al.,* 2019; Egner *et al.,* 1960), and the total and available forms of Cu, Zn, Mn and Fe by atomic absorption spectrophotometry according to the instructions specified in the ISO 11047 method (ISO, 1998).

To facilitate the reading of the article, the scheme of experiments is fully described in the section devoted to the results obtained and their discussion.

Results and Discussion

The effect of biohumus on the agrochemical properties of the soil when growing seedlings. It is known that cucumber seedlings grow rapidly and develop in a short period of time. This, in turn, requires the proper supply of soil with sufficient nutrients (N, P, K, Mg, Ca, trace elements). The number of nutrients necessary for the development of cucumber plants in the soil was determined.

One of the important elements in the development of seedlings of cucumbers is nitrogen. In the next period of seedling development, it is necessary to reduce the amount of nitrogen in the soil. This is important to reduce the accumulation of nitrates in the crop.

As established in a number of studies, an increase in the amount of nitrogen supplied to seedlings at the last stage of their development leads to an increase in the amount of nitrates in the cucumber crop. This situation increases the importance of using vermicompost when growing seedlings.

Despite the high amount of nitrogen contained in biohumus, its transition to the mobile phase (prolongation) in accordance with the level of absorption by plants, an excess amount of organic fertilizer adversely affects the development of plants and the agrochemical state of the soil will result in it not being displayed. Therefore, despite the fact that the amount of nitrogen in the substrate is quite large when biohumus is used, it does not adversely affect the growth of cucumber plants and does not cause a sharp change in the salt concentration in the soil.

At this stage of the work, the possibility of growing seedlings using a ready-made substrate (soil-wood chips) and biohumus (without mineral fertilizers) was studied.

The results of the agrochemical analysis of the composition of the initial soil mixture, manure and biohumus for the main nutrients before the start of the experiment are presented in Table 1.

The quantitative index of the main elements (N, P, K, Mg, Ca) in the manure used for growing seedlings depends on the composition of the forage base and the degree of decomposition of the manure. Therefore, during the years of research, the amount of nutrients in the biohumus used in the experiments had partially different indicators in different years, depending on the composition of the initial product (manure) during its preparation (Table 1). But from the conducted agrochemical studies, we see that the average three-year value of nutrients in biohumus (nitrogen, potassium, phosphorus, magnesium and calcium) remained unchanged and high.

According to the results of agrochemical analysis carried out before fertilization, the average annual indicator of nutrients in the substrate (soil-wood chips) is: nitrogen - 26.8 mg/l, phosphorus - 6.2 mg/l, potassium - 50.1 mg/l, magnesium - 14.1 mg/l and calcium - 53.0 mg/l (with water absorption 1:2, volumetric method). pH value 7.08, mixture density 0.43 g/cm^3. The amount of nutrients in the original soil is much lower than the amount needed for the development of the cucumber plant.

The control was a 1:1 mixture of soil and wood chips, which is widely used in most large greenhouses today. Mineral fertilizers (ammonium nitrate, double superphosphate and potassium sulfate) were used to ensure optimal values for the amount of nutrients in the initial mixture of the control variant.

In experiments, 600 g of ammonium nitrate, 125 g of granulated double superphosphate, 455 g of potassium chloride, and 115 g of magnesium sulfate salts were added per 1 m^3 of the initial mixture.

In addition, magnesium, iron, boron, manganese, copper, and molybdenum were added to the mixture. The experimentally determined amount of these elements in biohumus is: magnesium - 1.21%, iron - 267 mg / kg, zinc - 51 mg / kg, manganese - 63 mg / kg, copper - 3.9 mg / kg and cobalt - 0, 3 mg/kg.

In experiments conducted to study the effect of vermicompost on the agrochemical parameters of the substrate and the development of seedlings of cucumbers, its amount introduced into the substrate was changed from 10% to 100%. The experiments were carried out according to the following scheme:
Control option - substrate (soil: wood shavings = 1:1) + simple fertilizers (N_{180}; P_2O_{520}; K_2O_{300}) + trace elements;

90% substrate + 10% biohumus;

80% substrate + 20% biohumus;

70% substrate + 30% biohumus;

60% substrate + 40% biohumus;

50% substrate + 50% biohumus;

40% substrate + 60% biohumus;

30% substrate + 70% biohumus;

20% substrate + 80% biohumus;

10% substrate + 90% biohumus;

100% biohumus.

The results of agrochemical analysis of the composition of the substrate after the introduction of vermicompost for different options are presented in tables 2-3 below.

From the results presented in Table 2, the smallest amount of nutrients (NPK) in mixtures (N-83.8 mg/l, NH_4-9.9 mg/l, NO_3-73.8 mg/l, P_2O_5-11.7 mg/l, K_2O- 122.9 mg/l, MgO-21.8 mg/l, CaO-57.3 mg/l.) 0 mg/l, NH_4-73.5 mg/l, NO_3-532.6 mg/l, P_2O_5-61.3 mg/l, K_2O-773.5 mg/l, MgO-84.7 mg/l l, CaO-126.0 mg/l.) corresponds to the variant using 100% vermicompost. The ratio of batteries in this option is N-7.2, NH_4 -7.4, NO_3-7.2, P_2O_5 -5.2, K_2O-6.3, MgO-3.9, CaO-2, equal to 2.

The increase in the number of nutrients in the options increases in accordance with the increase in the amount of biohumus in their content and has the greatest value in the option with 10% biohumus according to different options, the average density of the substrate in 2019-2021. Varied within 0.21-0.50 g/cm^3, which corresponds to the amount of applied biohumus (table 2). The highest value of the density of the prepared mixture in different years corresponded to the 11th variant, and its lowest value was observed in the 2nd variant (Table 2). Also, with an increase in the amount of biohumus introduced into the substrate, the value of the salt concentration in its content increases within 0.537-3.573%. The agrochemical indicators of the substrate for 2019-2021 partially differ from each other in terms of the number of nutrients in biohumus during the years of research (Table 3), but the deviation from the average value is not so large. Analysis of the results presented in tables 1-3, based on the experience of the variants, it shows that the change in the amount of vermicompost in the substrate does not have a significant effect on the pH of the substrate.

Comparison of the amount of nutrients needed by the plant and their available values in the mixture presented in Table 2 in the second variant of the substrate with 10% biohumus containing nitrogen, phosphorus and potassium, and in the third variant in the substrate with 20% biohumus, the content of nitrogen and potassium was below their optimal values. Starting from the fourth option, containing 30% biohumus, the nutrients in the substrate have their optimal values. The number of nutrients in the substrate in the sixth and subsequent options increases from its optimal performance, corresponding to the amount of biohumus introduced.

Nutrients in the 10th variant, containing 90% biohumus, from the sum of nutrients in the 5th variant (40% biohumus): nitrogen-2.13, phosphorus-1.96, potassium-2.06, magnesium-1, 82 and Ca. be - 1.45 times higher.

So, when using vermicompost when growing seedlings according to options 2-3, it is necessary to add additional mineral fertilizers to bring the amount of nutrients in the substrate to optimal levels. When growing seedlings according to the following options, there is no need to use mineral fertilizers. Along with the total amount of nitrogen in the mobile form, the ammonium and nitrate forms were also controlled during the years of experience.

Comparison of the results of the analysis of the same options in different years shows the following general patterns. The agrochemical composition of the substrate used varies according to the options, in accordance with the amount of biohumus introduced into it. In this case, according to the amount of vermicompost, the amount of: N, K, P, Mg and Ca will have indicators below and above the optimal value. The difference between years in the content of the mixture is more pronounced for nitrogen in the nitrate form than for ammonium.

A low rate for nitrogen was observed in the second year of the experiment, and for phosphorus and magnesium in the first year of the experiment. The highest level of potassium and calcium corresponded to the 3rd year of the experience (2021). It is noted that the values of these elements, determined by the composition of the substrate in the 1st-2nd years of the experiment, do not differ sharply from each other.

In 3-year (2019-2021) experiments, there was no sharp change in the pH value of the mixture under the influence of vermicompost, but the specific gravity of the substrate differed over the years and the amount of vermicompost introduced into it. According to the results of agrochemical analysis, the amount of nutrients in the substrate reaches optimal values in initial mixtures containing 30-50% biohumus.

In order to fully determine the effect of the amount of biohumus on the agrochemical parameters of the substrate for growing seedlings, a chemical analysis of the composition of the mixture for planting seedlings at different stages of plant development was carried out. In these analyzes, the amount of macro-, microelements and heavy metals in the substrate was determined in accordance with different stages of seedling development. Table 4 presents the results of determining the agrochemical parameters of the substrate corresponding to the growth and development phases of cucumber seedlings in various variants for 2019-2021.

Table 4 shows that cucumber seedlings absorb nutrients strongly during development. The given values show that nitrogen is consumed in the soil more than potassium and phosphorus at the initial stages of seedling development. From the results of the analysis presented in table 5, it can be seen that the amount of nitrogen in the substrate corresponding to options 2-10 decreased in the range of 51-120 mg/l compared with its initial value.

During this period, the least changed (reduced) values of nitrogen compared to the initial content of the substrate prepared for planting are in the range of 51-58 mg/l, which corresponds to the substrate of options 2-6. Starting with a substrate containing 60% vermicompost, the decrease in nitrogen content compared to the initial value increases significantly. In the initial period of seedling development (the first 10 days), the decrease in the nitrogen content in the substrate containing 60-90% biohumus, compared with the initial values, was in the range of 19.5-40.2 mg/l, at 100% biohumus, 11-variant was used, this figure is 48.2 mg/l.

SHunday qilib tajribalardagi birinchi 10 kunda eng koʻp oʻzlashtirilgan azot miqdori tarkibida 90% biogumus boʻlgan 10-variantga va 100% biogumusdan foydalanilgan 11-variantlardagi substratlarga mos keldi.

So, in the first 10 days of experiments, the largest absorbed amount of nitrogen corresponded to the 10th variant with 90% vermicompost and the 11th variant using 100% vermicompost.

The total amount of absorbed nitrogen in the control variant, prepared using only mineral fertilizer at the stage before planting cucumber seedlings, is 75.1 mg/l. The above conditions are also observed in the change in the amount of absorbed ammonium and nitrogen in the form of nitrate in the substrate, suitable for different options, in the period before planting seedlings. The amounts of N-NH_4 and N-NO_3 assimilated by the seedling during development in variants 2-5 have very close values for different variants and 7.2-8.0 mg/l for N-NH_4 and N-NO_3 fluctuate within 43.8-50.4 mg/l.

Analysis of the dynamics of changes in the amount of nitrogen in the substrate at different stages of seedling development. The last stage of plant development, in options 8-11 and showed that the initial period of plant development corresponds to the 1st 10 days.

If the amount of absorbed nitrogen, corresponding to the seed-leaf phase of the seedling, in the control variant is 24% (18 mg/l) of the total absorbed nitrogen, then in the variants with 10-50% biohumus this figure is 21-25% equal.

All observed changes in the dynamics of the amount of nitrogen in the substrate according to different options correspond to the process of changing the amount of N-NH_4 and N-NO_3 ions in the substrate. Changes in the amount of N-NH_4 and N-NO_3 in substrates containing 10-50% biohumus have similar values for each ion, 1.9-2.6 mg/l for N-NH_4 and N-NO_3 equal to 9.1-12.0 mg/l. l.

Compared to the initial value of the amount of nitrogen, the smallest reduced amount of nitrogen absorbed by the plant at different stages of seedling development was compared with option 2 containing 10% biohumus (N-NH_4 -1.9 mg/l and N-NO_3 9.3). mg/l) and the 10th variant with the highest absorbed amount, containing 90% biohumus (N-NH_4 -5.1 mg/l and N-NO_3 -39.2 mg/l) and from 100% biohumus, corresponded to options 11 (N-NH_4 6.8). mg/l and N-NO3 -41.4 mg/l).

Analysis of the composition of the substrate shows that at the later stages of the development of cucumber seedlings, the rate of absorption of substrate nitrogen by the plant increases according to the same parameters. For example, in the control variant, the nitrogen uptake by the plant for every 10 days is 18, 26.3 and 30.8 mg/l, respectively, and this is the total nitrogen uptake - 24.8; 35.0 and 41%. The patterns of changes in the amount of nitrogen in variants with 10-50% biohumus at different stages of plant development correspond to changes in nitrogen in the control variant, that is, in these variants, the amount of nitrogen consumed increases at each stage of plant development next stage of plant development. From the tables we observe such a change in $N\text{-}NH_4$ and $N\text{-}NO_3$.

With a further increase in biohumus in the substrate, a change in the dynamics of nitrogen content is observed. Starting from a substrate with 70% vermicompost, it was observed that the amount of nitrogen does not increase, but decreases at later stages of plant development. For example, in option 9 containing 80% biohumus, the dynamics of nitrogen content in the substrate, corresponding to different stages of seedling development, was -34.2 mg/l in the first 10 days, -31.3 mg/l in the second 10 days. days, and -31.3 mg/l, in the third 10 it turned out to be -29.4 mg/l per day.

In the experiments, changes were also observed in the dynamics of $N\text{-}NH_4$ and $N\text{-}NO_3$ in the substrate, which are characteristic of changes in the amount of nitrogen (Table 5). Thus, the dynamics of changes in the amount of nitrogen in the substrate when growing cucumber seedlings corresponds to a change in the amount of vermicompost in the mixture, the amount of vermicompost up to 50%, total nitrogen in the mobile form and its $N\text{-}NH_4$, which is consumed at later stages of plant development, and the amount of N forms. $\text{-}NO_3$ increases. In the following concentrations of vermicompost, the amount of useful nitrogen decreases with an increase in the next time from the day of sowing.

Phosphorus and potassium are important nutrients in the development of cucumber plants. In table. Figure 5 shows the dynamics of changes in the content of phosphorus and potassium in the substrate, corresponding to different stages of seedling development. As can be seen from Table 5, the total amount of phosphorus and potassium in the substrate, corresponding to different options, corresponding to the full period of seedling development, is in the range of 8.0-14.7 mg/l for phosphorus and potassium change within 45.0-136.1 mg/l. The smallest change in the amount of phosphorus and potassium in the substrate corresponds to options 2-4 containing from 10% to 30% biohumus.

The corresponding decrease in phosphorus in these variants is 8.0-8.1 mg/l, and the decrease in potassium is 45.0-51.1 mg/l. Phosphorus, which is reduced from the composition of the substrate, corresponding to an increase in the amount of biohumus from 60 to 90%, is 9.6-12.8 mg/l, potassium - 67.0-110.7 mg/l. The dynamics of changes in the amount of phosphorus, corresponding to different stages of plant development during the period of seedlings from the sowing to the leaf phase, with an increase in the content of biohumus in the substrate, the amount of phosphorus consumed is in the range of 29-56% compared to the total amount of phosphorus consumed, shows a change. At the next stages of plant development (the second and third decades), the amount of phosphorus used in the same variants practically does not differ.

Also, at the later stages of plant development, the change (decrease) in the amount of phosphorus in substrates containing 80-100% biohumus is less than at the initial stages of the experiment.

For example, the consumption of phosphorus in a substrate containing 90% biohumus during seedling development is -49% in the first 10 days, -29% in the second 10 days and -22% in the third 10 days compared to the total reduced amount of phosphorus.

Table.1 Agrochemical characteristics of the initial mixture, manure and biohumus

S. №	Year of study	pH	Amount of nutrients, mg/l							Salt concentration %	Density, g/cm3
			N	NN_4^+	NO_3^-	P_2O_5	K_2O	MgO	CaO		
Substrate (soil - wood shavings = 1:1)											
1	2019	7,02	26,9	2,9	24,0	6,6	44,6	10,0	56,0	0,230	**0,50**
2	2020	7,12	25,2	2,6	22,6	6,1	51,3	15,5	50,0	0,200	**0,55**
3	2021	7,10	28,2	3,2	24,9	5,9	54,4	16,9	53,0	0,180	**0,54**
4	Average 2019-2021	7,08	26,8	2,9	23,8	6,2	50,1	14,1	53,0	0,203	**0,53**
Manure											
5	2019	5,89	237,4	32,2	205,1	20,6	129,3	22,7	17,8	0,515	**0,35**
6	2020	6,45	210,6	28,3	194,2	23,9	158,8	26,3	12,9	0,580	**0,40**
7	2021	6,16	326,5	35,1	301,4	26,9	188,0	28,0	13,6	0,753	**0,41**
8	Average 2019-2021	6,20	258,2	31,9	233,6	23,8	158,7	25,7	14,8	0,616	**0,39**
Biohumus											
9	2019	6,94	541,2	73,5	467,7	54,4	650,0	66,0	108,5	3,09	**0,51**
10	2020	7,11	486,9	66,9	420,0	60,5	762,8	82,5	127,5	2,93	**0,48**
11	2021	7,04	790,0	80,0	710,0	69,0	907,6	105,5	142,0	4,70	**0,44**
12	**Average 2019-2021**	**7,03**	**606,0**	**73,5**	**532,6**	**61,3**	**773,5**	**84,7**	**126,0**	**3,573**	**0,47**

Table.2 Agrochemical indicators of the substrate for growing seedlings of cucumbers (average for 2019-2021)

№	Mixture, % volume	pH	The amount of nutrients in the mixture, mg/l							Salt	Density g/cm³
			N-general	NN_4	NO_3	P_2O_5	K_2O	MgO	CaO		
1	Control*	6,95	181,4	22,4	159,0	19,2	237,0	33,9	98,6	1,134	**0,16**
2	Sub-90: bioh-10	6,98	83,8	9,9	73,3	11,7	122,9	21,8	57,3	0,537	**0,21**
3	Sub-80: bioh-20	6,79	141,4	17,2	124,4	17,2	195,3	28,8	64,4	0,875	**0,28**
4	Sub-70: bioh-30	6,97	199,4	24,8	175,4	22,7	267,6	35,7	71,4	1,212	**0,27**
5	Sub-60: bioh-40	6,99	257,5	31,4	226,4	28,4	339,9	42,7	78,4	1,549	**0,33**
6	Sub-50: bioh-50	6,97	345,6	38,2	277,5	33,7	412,3	49,7	85,4	1,887	**0,42**
7	Sub-40: bioh-60	6,99	373,7	45,6	328,5	39,6	484,6	56,7	92,5	2,224	**0,44**
8	Sub-30: bioh-70	6,92	451,8	52,3	379,5	44,7	556,9	63,7	99,5	2,561	**0,33**
9	Sub-20: bioh-80	6,99	489,8	59,8	430,5	50,5	629,3	70,7	106,5	2,898	**0,46**
10	Sub-10: bioh -90	6,87	547,9	66,4	481,6	55,7	701,6	77,7	113,6	3,236	**0,47**
11	Biohumus-100	7,03	606,0	73,5	532,6	61,3	773,5	84,7	126,0	3,573	**1,50**
Elements that must be present			**165-250**	**15-20**	**150-230**	**15-30**	**200-250**	**10-15**	**73-108**		

*Control – (soil+wood shavings 1:1+ $N_{180}P_2O_{520}K_2O_{300}$). Sub.- soil:wood shavings = 1:1), bioh. – biohumus.

Table.3 Agrochemical indicators of different years, corresponding to the amount of biohumus in the soil of the greenhouse

№	Mixture, % volume	pH	The amount of nutrients in the mixture, mg/l							Salt
			N-general	NN_4	NO_3	P_2O_5	K_2O	MgO	CaO	
2019 year										
1	Control	6,88	156,4	10,8	145,8	17,5	214,4	28,8	90,7	**1,043**
2	Sub-90: bioh -10	7,06	73,8	9,9	63,8	11,8	106,4	17,4	54,0	**0,516**
3	Sub-80: bioh -20	6,89	125,8	17,2	108,7	16,6	166,8	22,8	60,1	**0,802**
4	Sub-70: bioh -30	6,88	177,7	24, 8	153,6	20,9	227,2	28,2	66,1	**1,088**
5	Sub-60: bioh -40	7,04	229,6	31, 4	198,5	25,7	287,6	33,6	72,2	**1,374**
6	Sub-50: bioh -50	6,98	281,6	38,2	243,4	30,5	348,0	39,0	78,2	**1,660**
7	Sub-40: bioh -60	7,1	333,5	45, 6	288,2	35,8	408,4	44,4	84,3	**1,946**
8	Sub-30: bioh -70	6,86	385,4	52,3	333,1	40,6	468,8	49,8	90,3	**2,232**
9	Sub-20: bioh -80	7,06	437,3	59, 8	378,0	44,8	529,2	55,2	96,4	**2,518**
10	Sub-10: bioh -90	6,9	489,3	9,96	422,8	49,6	589,6	60,6	102,4	**2,804**
11	Biohumus-100	6,94	541,2	73,5	467,7	54,4	650,0	56,0	108,5	**3,090**
2020 year										
1	Control	7,06	186	15	169,2	20	256,6	35	104,5	**1,234**
2	Sub-90: bioh -10	6,98	72,6	9,9	62,7	11,5	80,9	22,2	55,8	**0,473**
3	Sub-80: bioh -20	6,59	118,7	16,6	102,4	16,9	135,1	28,9	61,7	**0,746**
4	Sub-70: bioh -30	7,06	164,7	22,5	142,1	22,4	200,4	35,6	67,5	**1,019**
5	Sub-60: bioh -40	6,96	210,7	28,9	181,8	27,8	265,0	42,3	73,4	**1,292**
6	Sub-50: bioh -50	6,9	256,8	35,5	221,5	33,3	325,4	49,0	79,2	**1,565**
7	Sub-40: bioh -60	6,96	302,8	41,5	261,2	38,7	390,4	55,7	85,1	**1,838**
8	Sub-30: bioh -70	7,01	348,8	47,9	300,9	44,8	455,8	62,4	90,9	**2,111**
9	Sub-20: bioh -80	6,93	394,8	54,2	340,6	49,6	520,6	69,1	96,8	**2,384**
10	Sub-10: bioh -90	6,85	440,9	60,5	380,3	55,6	585,6	75,8	102,6	**2,657**
11	Biohumus-100	7,11	486,9	66,9	420,0	60,5	762,8	82,5	127,5	**2,930**
2021 year										
1	Control	6,91	171,7	12,1	162,2	20,1	240,3	37,9	100,6	**1,134**
2	Sub-90: bioh -10	6,91	103,5	10,7	93,4	12,2	139,7	25,7	61,9	**0,632**
3	Sub-80: bioh -20	6,89	179,8	17,8	161,9	18,5	225,1	34,6	70,8	**1,084**
4	Sub-70: bioh -30	6,97	256,0	25,6	230,4	24,8	310,4	43,4	79,7	**1,536**
5	Sub-60: bioh -40	6,97	332,3	33,8	298,9	31,4	395,8	52,3	88,6	**1,988**
6	Sub-50: bioh -50	7,04	408,6	41,5	367,5	37,4	481,2	61,0	97,5	**2,440**
7	Sub-40: bioh -60	6,91	484,9	48,9	436,5	43,7	566,5	70,0	106,4	**2,892**
8	Sub-30: bioh -70	6,89	561,2	56,6	504,5	50,7	651,9	78,9	115,3	**3,344**
9	Sub-20: bioh -80	6,98	637,4	64,4	573,6	56,8	737,2	87,7	124,2	**3,796**
10	Sub-10: bioh -90	6,86	713,7	72,2	641,5	62,9	822,6	96,6	133,1	**4,248**
11	**Biohumus-100**	**7,04**	**790,0**	**80,0**	**710,0**	**69,0**	**907,6**	**105,5**	**142,0**	**4,700**

Table.4 Agrochemical indicators of the substrate for growing seedlings, corresponding to the phases of growth and development of the seedling in different years (average 2019-2021)

S. №	Mixture, % volume	pH	The amount of nutrients in the mixture, mg/l							Salt
			N-general	NN_4	NO_3	P_2O_5	K_2O	MgO	CaO	
Composition of the substrate ready for planting.										
1	Control	6,95	181,4	22,4	159,0	19,2	237,0	33,9	98,6	**1,134**
2	Sub-90: bioh -10	6,98	83,8	9,9	73,3	11,7	122,9	21,8	57,3	**0,537**
3	Sub-80: bioh -20	6,79	141,4	17,2	124,4	17,2	195,3	28,8	64,4	**0,875**
4	Sub-70: bioh -30	6,97	199,4	24,8	175,4	22,7	267,6	35,7	71,4	**1,212**
5	Sub-60: bioh -40	6,99	257,5	31,4	226,4	28,4	339,9	42,7	78,4	**1,549**
6	Sub-50: bioh -50	6,97	345,6	38,2	277,5	33,7	412,3	49,7	85,4	**1,887**
7	Sub-40: bioh -60	6,99	373,7	45,6	328,5	39,6	484,6	56,7	92,5	**2,224**
8	Sub-30: bioh -70	6,92	451,8	52,3	379,5	44,7	556,9	63,7	99,5	**2,561**
9	Sub-20: bioh -80	6,99	489,8	59,8	430,5	50,5	629,3	70,7	106,5	**2,898**
10	Sub-10: bioh -90	6,87	547,9	66,4	481,6	55,7	701,6	77,7	113,6	**3,236**
11	Biohumus-100	7,03	606,0	73,5	532,6	61,3	773,5	84,7	126,0	**3,573**
The composition of the substrate in the seed-leaf stage of the plant										
1	Control	6,86	163,4	18,5	144,9	18,9	223,9	30,2	92,7	**1,043**
2	Sub-90: bioh -10	6,94	72,6	8,0	63,7	9,3	111,7	19,5	52,6	**0,516**
3	Sub-80: bioh -20	6,91	130,4	15,3	114,1	14,7	185,7	27,1	59,8	**0,802**
4	Sub-70: bioh -30	6,96	187,7	22,6	164,5	20,3	255,9	33,6	67	**1,088**
5	Sub-60: bioh -40	6,94	244,9	29,2	215,4	26,0	327,2	40,3	77,6	**1,374**
6	Sub-50: bioh -50	6,94	331,0	35,6	264,4	31,1	395,5	46,9	81,3	**1,660**
7	Sub-40: bioh -60	6,82	354,2	42,4	310,5	36,6	464,5	53,2	87,3	**1,946**
8	Sub-30: bioh -70	6,94	425,0	48,5	356,2	40,9	533,3	59,5	93,5	**2,232**
9	Sub-20: bioh -80	6,84	455,6	55,2	398,4	45,3	599,5	66,4	98,2	**2,518**
10	Sub-10: bioh -90	6.88	507,7	61,3	443,6	49,4	682,8	73,5	104,8	**2,804**
11	Biohumus-100	6,97	557,8	66,7	485,4	53,1	757,2	80,5	116,7	**3,090**
The composition of the substrate in the phases of the present three-leaf plant										
1	Control	7,10	137,1	14,1	123,4	14,7	201,3	23,3	85,3	**1,234**
2	Sub-90: bioh -10	7,04	54,2	5,5	48,8	6,6	95,5	15,8	46,8	**0,473**
3	Sub-80: bioh -20	7,17	111,5	12,7	98,9	12,1	167,5	23,2	54,1	**0,746**
4	Sub-70: bioh -30	6,98	168,1	20,1	148,7	17,7	237,0	29,6	64,8	**1,019**
5	Sub-60: bioh -40	6,93	224,5	26,9	198,7	23,3	310,0	36,4	76,6	**1,292**
6	Sub-50: bioh -50	6,99	311,1	33,2	247,3	28,2	376,0	42,6	79,2	**1,565**
7	Sub-40: bioh -60	6,98	332,0	39,8	291,9	33,2	441,7	49,1	80,3	**1,838**
8	Sub-30: bioh -70	7,09	399,0	45,4	333,6	37,0	506,4	55,3	86,1	**2,111**
9	Sub-20: bioh -80	6,90	424,3	51,5	372,9	40,7	568,7	62,2	92,7	**2,384**
10	Sub-10: bioh -90	6,96	476,0	57,2	416,7	45,7	645,2	70,0	95,3	**2,657**
11	Biohumus-100	7,02	520,5	62,2	456,0	49,8	708,2	77,4	96,8	**2,930**

Substrate composition when the plant is ready to be transplanted									
1	Control	7,14	106,3	8,9	97,6	10,2	177,5	16,2	73,9	**1,134**
2	Sub-90: bioh -10	7,13	32,8	2,6	29,5	3,7	77,9	12,0	38,5	**0,632**
3	Sub-80: bioh -20	7,10	89,0	9,5	79,7	9,2	147,3	19,1	45,3	**1,084**
4	Sub-70: bioh -30	7,04	146,4	17,0	130,2	14,7	216,6	25,5	59,4	**1,536**
5	Sub-60: bioh -40	6,93	202,5	24,0	178,7	20,0	290,9	32,7	75,2	**1,988**
6	Sub-50: bioh -50	6,92	287,2	30,2	227,1	25,1	358,1	38,9	77,9	**2,440**
7	Sub-40: bioh -60	6,87	306,5	36,4	270,4	29,9	417,6	44,6	79,9	**2,892**
8	Sub-30: bioh -70	7,13	370,6	41,7	308,9	33,9	475,5	49,7	84,6	**3,344**
9	Sub-20: bioh -80	7,02	394,9	47,4	348,2	38,1	529,9	55,3	88,9	**3,796**
10	Sub-10: bioh -90	6,82	442,2	53,3	388,9	42,9	591,0	61,0	95,0	**4,248**
11	**Biohumus-100**	**7,15**	**485,6**	**58,0**	**427,7**	**46,6**	**637,4**	**65,5**	**93,8**	**4,700**

The amount of potassium in the substrate, other than phosphorus, increases in the later stages of plant development at high concentrations of vermicompost. For example, the distribution of potassium in a substrate containing 90% vermicompost in relation to the total potassium intake is -17% in the first 10 days, -34% in the second 10 days and -49% in the third 10 days. Important elements in the development of cucumber seedlings are the elements of magnesium and calcium in the soil. The lack of magnesium and calcium elements in the soil causes the appearance of various spots on the leaves of the cucumber plant and the rapid yellowing of the leaves. The reduction of magnesium from the composition of the prepared substrate according to different options corresponding to different stages of plant development in tables 4-5 is 9.8-16.6 mg/l, and the reduction of calcium is 18.8-28.3 mg/l. l. Soil analysis at different stages of plant development showed that the amount of magnesium and calcium consumed during this period has stable values.

The following agrochemical analysis of the composition of the mixture at the last stage of seedling cultivation, that is, when seedlings are transferred to the main place, is presented in Table 6.

The average three-year value of nutrients in the mixture prepared according to option 5 from table 6: N-189.1 mg/l, NH_4-18.0 mg/l, NO_3-178.7 mg/l, P_2O_5-20.0 mg/l, K_2O -270.9 mg/l, MgO-28.7 mg/l, CaO-74.1 mg/l must be present in the substrate for growing cucumbers. It has been observed that the amount of nutrients is fully compatible. The results of the experiments presented in Table 6 show that in mixtures with a biohumus content in the substrate below 40%, the norm of nutrients decreases from the optimal values at the end of sowing. The number of nutrients in the mixture after planting seedlings with the amount of vermicompost more than 40% in the substrate is higher than their optimal values.

Table.5 Dynamics of changes in the nutrients of the substrate for growing seedlings in different years to the phases of growth and development of the seedling (average for 2019-2021)

№	**Mixture, % volume**	**N-general**		**NH_4**		**NO_3**		**P_2O_5**		**K_2O**		**MgO**		**CaO**	
		mg/l	A,%	mg/l	A,%	mg/l	A,%	mg/l	A,%	mg/l	A,%	mg/l	A,%	mg/l	**A,%**
The total amount of nutrients consumed during the full development of the seedling (for 30 days)															
1	Control	75,1	100	13,7	100	61,4	100	12,9	100	59,4	100	17,7	100	24,8	**100**
2	Sub-90: bioh -10	51,0	100	7,2	100	43,8	100	8,0	100	45,0	100	9,8	100	18,8	**100**
3	Sub-80: bioh -20	52,4	100	7,7	100	44,7	100	8,1	100	48,2	100	9,8	100	19,1	**100**
4	Sub-70: bioh -30	53,0	100	7,8	100	45,2	100	8,0	100	51,1	100	10,2	100	20	**100**
5	Sub-60: bioh -40	55,0	100	7,4	100	47,6	100	8,4	100	49,0	100	10,1	100	20,8	**100**
6	Sub-50: bioh -50	58,4	100	8,0	100	50,4	100	8,6	100	54,2	100	10,8	100	21,5	**100**
7	Sub-40: bioh -60	67,2	100	9,2	100	58	100	9,6	100	67,0	100	12,2	100	22,6	**100**
8	Sub-30: bioh -70	81,1	100	10,6	100	70,5	100	10,8	100	81,4	100	13,9	100	24,9	**100**
9	Sub-20: bioh -80	94,9	100	12,5	100	82,4	100	12,3	100	99,5	100	15,4	100	27,6	**100**
10	Sub-10: bioh -90	105,7	100	13,1	100	92,6	100	12,8	100	110,7	100	16,6	100	28,3	**100**
11	Biohumus-100	120,4	100	15,5	100	104,9	100	14,7	100	136,1	100	19,2	100	32,2	**100**
The number of nutrients consumed before the seedling reaches the leaf phase (in the first 10 days)															
1	Control	18,0	24	4,1	30	13,9	23	4,1	32	13,1	22	3,7	21	5,9	**24**
2	Sub-90: bioh -10	11,2	22	1,9	26	9,3	22	2,4	30	11,2	25	2,3	23	4,7	**25**
3	Sub-80: bioh -20	11,0	21	1,9	25	9,1	23	2,5	31	9,6	20	1,7	18	4,6	**24**
4	Sub-70: bioh -30	11,7	22	2,2	28	9,5	24	2,4	30	11,7	23	2,1	21	4,4	**22**
5	Sub-60: bioh -40	12,6	23	2,2	30	10,4	23	2,4	29	12,7	26	2,4	24	4,8	**23**
6	Sub-50: bioh -50	14,6	25	2,6	32	12	26	2,6	30	16,8	31	2,8	26	4,1	**19**
7	Sub-40: bioh -60	19,5	29	3,2	35	16,3	31	3,0	31	20,1	30	3,5	29	5,2	**23**
8	Sub-30: bioh -70	26,8	33	3,8	36	23	33	3,8	35	23,6	29	4,2	30	6,0	**24**
9	Sub-20: bioh -80	34,2	36	4,6	37	29,6	39	5,2	42	29,8	30	4,3	28	8,3	**30**
10	Sub-10: bioh -90	40,2	38	5,1	39	35,1	41	6,3	49	18,8	17	4,2	25	8,8	**31**
11	Biohumus-100	48,2	40	6,8	44	41,4	45	8,2	56	16,3	12	4,2	22	9,3	**29**

The amount of nutrients consumed before the seedling reaches the phase of three leaves (in the second 10 days)														
1	Control	26,3	35	4,4	32	21,9	35	4,3	33	22,6	38	6,9	39	7,4	**30**
2	Sub-90: bioh -10	18,4	36	2,5	34	15,9	34	2,7	34	16,2	36	3,7	38	5,8	**31**
3	Sub-80: bioh -20	18,9	36	2,6	34	16,3	34	2,6	33	18,2	38	3,9	40	5,7	**30**
4	Sub-70: bioh -30	19,6	37	2,5	32	17,1	35	2,6	33	18,9	37	4,0	39	6,2	**31**
5	Sub-60: bioh -40	20,4	37	2,3	31	18,1	35	2,7	32	17,2	35	3,9	39	6,0	**29**
6	Sub-50: bioh -50	19,9	34	2,4	30	17,5	34	2,9	34	19,5	36	4,3	40	7,1	**33**
7	Sub-40: bioh -60	22,2	33	2,6	28	19,6	32	3,4	35	22,8	34	4,1	34	7,0	**31**
8	Sub-30: bioh -70	26,0	32	3,1	29	22,9	32	3,9	36	26,9	33	4,2	30	7,4	**30**
9	Sub-20: bioh -80	31,3	33	3,7	30	27,6	31	4,6	37	30,8	31	4,2	27	5,5	**20**
10	Sub-10: bioh -90	31,7	30	4,1	31	27,6	29	3,7	29	37,6	34	3,5	21	6,2	**22**
11	Biohumus-100	37,3	31	4,5	29	32,8	28	3,3	22	49,0	36	3,1	16	6,8	**21**
The number of batteries consumed before the seedlings are ready for planting (3rd in 10 days)														
1	Control	30,8	41	5,2	38	25,6	42	4,5	35	23,8	40	7,1	40	11,4	**46**
2	Sub-90: bioh -10	21,4	42	2,9	40	18,5	44	2,9	36	17,6	39	3,8	39	8,3	**44**
3	Sub-80: bioh -20	22,5	43	3,2	41	19,3	43	2,9	36	20,2	42	4,1	42	8,8	**46**
4	Sub-70: bioh -30	21,7	41	3,1	40	18,6	41	3,0	37	20,4	40	4,1	40	9,4	**47**
5	Sub-60: bioh -40	22,0	40	2,9	39	19,1	42	3,3	39	19,1	39	3,7	37	9,9	**48**
6	Sub-50: bioh -50	23,9	41	3,0	38	20,9	40	3,1	36	17,9	33	3,7	34	10,3	**48**
7	Sub-40: bioh -60	25,5	38	3,4	37	22,1	37	3,3	34	24,1	36	4,5	37	10,4	**46**
8	Sub-30: bioh -70	28,4	35	3,7	35	24,7	35	3,1	29	30,9	38	5,6	40	11,5	**46**
9	Sub-20: bioh -80	29,4	31	4,1	33	25,3	30	2,6	21	38,8	39	6,9	45	13,8	**50**
10	Sub-10: bioh -90	33,8	32	3,9	30	29,9	30	2,8	22	54,2	49	9,0	54	13,3	**47**
11	**Biohumus-100**	**34,9**	**29**	**4,2**	**27**	**30,7**	**27**	**3,2**	**22**	**70,8**	**52**	**11,9**	**62**	**16,1**	**50**

Table.6 Agrochemical characteristics of the substrate after growing cucumber seedlings (average for 2019-2021)

№	Mixture for growing seedlings, % wt.	pH	The amount of nutrients in the mixture, mg/l						
			N-general	NH_4	NO_3	P_2O_5	K_2O	MgO	CaO
1	Control	6,93	98,3	8,9	97,6	10,2	177,5	16,2	**73,9**
2	Sub-90: bioh -10	6,92	30,8	2,6	29,5	3,7	77,9	12,0	**36,5**
3	Sub-80: bioh -20	7,02	81,0	9,5	79,7	9,2	147,3	16,1	**41,3**
4	Sub-70: bioh -30	6,82	135,4	14,0	130,2	14,7	196,6	19,5	**57,4**
5	Sub-60: bioh -40	6,88	189,1	18,0	178,7	20,0	270,9	28,7	**74,1**
6	Sub-50: bioh -50	6,86	267,0	30,2	227,1	25,1	338,1	32,9	**75,9**
7	Sub-40: bioh -60	6,82	306,5	36,4	270,4	29,9	417,6	44,6	**78,6**
8	Sub-30: bioh -70	7,02	353,1	41,7	308,9	33,9	475,5	49,7	**84,1**
9	Sub-20: bioh -80	6,95	382,6	47,4	348,2	38,1	529,9	55,3	**86,9**
10	Sub-10: bioh -90	6,80	429,2	53,3	388,9	42,9	591,0	61,0	**92,4**
11	Biohumus-100	6,95	467,2	58,0	427,7	46,6	637,4	65,5	**92,8**
Sum available, according to Glunsov [1979]			**165-250**	**15-20**	**150-230**	**15-30**	**200-250**	**10-15**	**73-108**

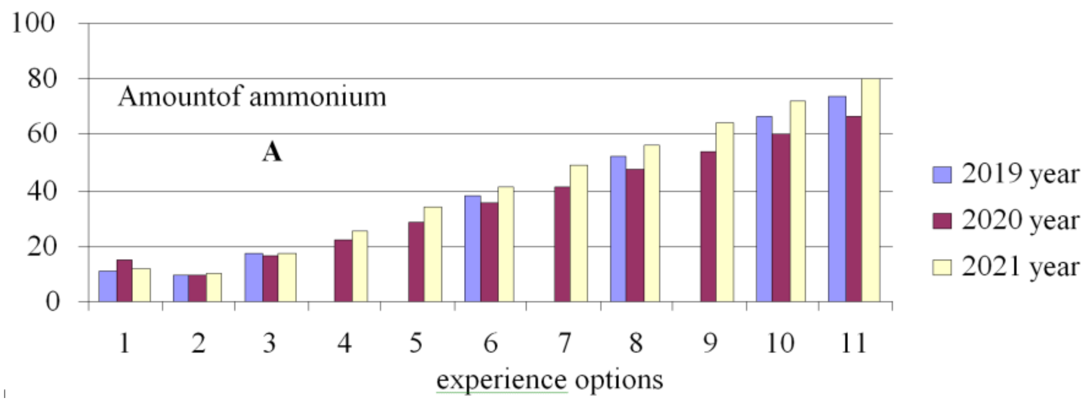
Table.7 The amount of heavy metals in mobile form in the seedling mixture with different content of vermicompost, (mg/kg)

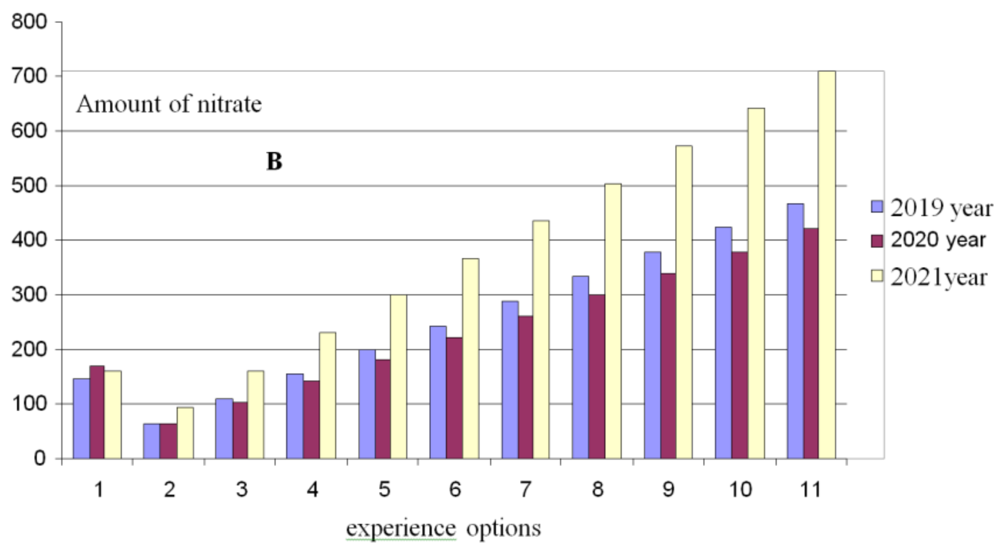
№	Options	Cd	Co	Cr	Cu	Mn	Ni	Pb	Zn	Mo
1	Control	0,30	0,50	4,60	2,96	49,50	0,87	6,11	23,00	**0,22**
2	Sub-90: bioh -10	0,15	0,31	3,90	2,05	34,80	0,55	4,45	12,60	**0,20**
3	Sub-80: bioh -20	0,15	0,30	3,10	1,90	30,00	0,50	3,50	11,00	**0,20**
4	Sub-70: bioh -30	0,12	0,25	2,40	0,95	25,55	0,46	2,00	8,50	**0,18**
5	Sub-60: bioh -40	0,09	0,20	2,20	0,51	24,50	0,38	1,10	4,60	**0,15**
6	Sub-50: bioh -50	0,07	0,20	2,10	0,48	21,90	0,37	0,59	4,20	**0,15**
7	Sub-40: bioh -60	0,06	0,15	2,00	0,45	17,60	0,35	0,50	3,74	**0,14**
8	Sub-30: bioh -70	0,06	0,15	2,00	0,40	13,85	0,30	0,50	3,60	**0,14**
9	Sub-20: bioh -80	0,05	0,10	1,80	0,38	11,00	0,28	0,45	3,30	**0,13**
10	Sub-10: bioh -90	0,05	0,05	1,60	0,36	8,90	0,25	0,40	3,00	**0,12**
11	Biohumus-100	0,05	0,05	1,50	0,35	6,55	0,22	0,35	2,55	**0,12**
MPC value of heavy metals in soil		**-**	**5,0**	**6,0**	**3,0**	**-**	**4,0**	**-**	**230**	**-**

Table.8 The amount of heavy metals in mobile form in the soil and the level of its pollution (on air-dry soil), mg/kg (Obukhov, 1992)

Gradation	Pb	Cd	Zn	Cu	Ni	Co
Quantity, mg/kg						
Very low	<0,2	<0,02	<1	<0,2	<0,2	<0,1
Short	0,2-0,5	0,02-0,05	1-2	0,2-0,5	0,2-0,5	0,1-0,2
Average	0,5-1,5	0,05-0,10	2-5	0,5-2,0	0,5-1,5	0,2-0,5
High	1,5-5,0	0,10-0,50	5-20	2,0-5,0	1,5-5,0	0,5-3,0
Pollution, mg/kg						
Weak (MPC)	5-10	0,5-1,0	20-50	5-10	5-10	3-5
Average	10-50	1,0-3,0	50-100	10-50	10-50	5-25
Strong	50-100	3,0-5,0	100-200	50-100	50-100	25-50
Very strong	>100	>5,0	>200	>100	>100	>50

Fig.1 Change in the amount of ammonium (A) and nitrate (B) in the intensification mixture in 2019-2021 depending on the amount of applied biohumus





The experiments have shown that the optimal size of the substrate for growing cucumber seedlings "Avicina G1" without the use of mineral fertilizers in greenhouse conditions corresponds to option 5, containing 40% biohumus. The amount of residual nutrients in the mixture prepared according to this option, after planting the seedlings, will retain its optimal performance.

Thus, the results of agrochemical analysis of the composition of the substrate at different stages of development of seedlings in the conditions of greenhouses in the Samarkand region, the use of a mixture of soil and chips 1:1 with 40% biohumus in the conditions of greenhouses in the Samarkand region. cultivation of seedlings of cucumbers without the use of mineral fertilizers leads to optimal biometric indicators, showed that this allows growing seedlings of cucumbers.

One of the unique aspects of greenhouse conditions is the relatively high humidity and temperature. These conditions cause the growth and development of pathogenic fungi, bacteria and viruses. In most cases, when growing seedlings of cucumbers, it is necessary to treat the plant from fungal diseases. Plant pathogens remain mainly in the soil. In the experiments, it was noted that the disease resistance of seedlings planted with vermicompost increased when the cucumber planted according to the control variant was infected. This allows us to conclude that biohumus increases the protection of cucumbers from fungal diseases in greenhouse conditions.

Thus, the use of vermicompost when growing cucumber seedlings stabilizes the agrochemical parameters of the soil in greenhouse conditions, reduces the seedling maturation period, and increases the plant's resistance to fungal diseases.

Visual observations of the state of seedlings during the development period showed that from the initial period of development, in the variant with an equal amount of soil and chips and in the variant with 10-20% vermicompost, at the last stages of seedling development, nitrogen deficiency was noted in the variant with 30% vermicompost. Also, the plants of these variants had a yellowish-lemon color of varying intensity. In the control variant, no nutrient deficiency was observed at all stages of plant development. The lack of nutrients in the process of plant development was fully confirmed by visual observations as a result of agrochemical analyzes of the soil in the paddocks at the end of the indicated sowing period.

In the course of the studies, the influence of the amount of heavy metals in the mixture used for growing biohumus was studied. A sensitive way to assess the level of soil contamination with heavy metals is to determine their mobile form (Plekhanova *et al.,* 1995), since it is in this form that metals first pass into the plant and through it into the human body.

The determination of the amount of heavy metals in the substrate was carried out according to the Petrov method. The results obtained are presented in table 7, and for comparison, the table shows the value of the permissible limit (MAC) of heavy metals in the composition of the officially approved greenhouse soil.

Comparison of the amount of heavy metals in a mixture containing different amounts of vermicompost with MPC, presented in table. 7 it was shown that the amount of metals and the metals used were acceptable. Table 8 shows the degree of soil contamination according to Obukhov (1992) according to the heavy metals present in it.

Comparison of the results of soil analysis, where seedlings were grown with the classification of Obukhov, presented in Table 8, as a control variant prepared from soil and wood chips in a ratio of 1:1 using mineral fertilizers, the mixture itself contains heavy metals, it can be seen that it is slightly contaminated with lead (6.11 mg/kg) and zinc (23.00 mg/kg) (Marreiro *et al.,* 2017).

Senad Murtić *et al.,* also assessed the uptake and distribution levels of the main heavy metals Cu, Zn, Mn and Fe in cucumber plants (Cucumis sativus L. 'Opalit F1') (Senad Murtić *et al.,* 2019). The authors argue that the accumulation of Mn and Zn was higher in the root and leaves than in the stem and fruits, and the accumulation of Cu and Fe in the root is significantly higher than in all aboveground parts of the cucumber. Since the concentration of heavy metals in cucumber was below the recommended limits set by the World Health Organization, the consumption of cucumber grown in the studied soil, in terms of soil contamination with the tested heavy metals, should not pose a risk to human health (Senad Murtić *et al.,* 2019). The soil is rich in cadmium (0.30 mg/kg) and copper (2.96 mg/kg) and poor in cobalt (0.50 mg/kg) and nickel (0.87 mg/kg), which corresponds to the gradation with average values. In all cases, the introduction of biohumus into the substrate leads to a decrease in the amount of heavy metals in the mixture. The amount of lead in the control sample was 6.11 mg/kg, and when biohumus was added to it in a ratio of 1:9, the amount of lead decreased to 0.40 mg/kg. In the experiments, a significant decrease in the amount of heavy metals in the mixture under the influence of vermicompost in the range of 10-50% vermicompost is noticeable.

Therefore, biologically active fertilizer-biohumus increases the buffering capacity of the soil and acts as a good sorbent of heavy metal cations in its soil. As a result, the introduced biohumus reduces the amount of mobile heavy metals in the soil.

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