



**PROSPECTS FOR THE ECOLOGICAL AND AGRONOMIC EVALUATION  
OF THE USE OF HUMIC PREPARATIONS AND MUSHROOM  
PRODUCTION WASTE IN CUCUMBER SEEDLING CULTIVATION**

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**Abstract**

Cucumber (*Cucumis sativus* L.) is one of the most widely cultivated vegetable crops, beneficial for human health, rich in vitamins, and of high nutritional value. Year-round cultivation in greenhouses plays an important role in meeting the nutritional needs of the population. At the same time, one of the most crucial factors for obtaining high yields in greenhouse farming is improving seedling quality and shortening the growing period. Therefore, the use of new, environmentally friendly components and growth stimulants in cucumber seedling cultivation is one of the pressing areas of scientific research.

These studies were conducted in the greenhouse conditions of the educational and experimental farm at Tashkent State Agrarian University. The main goal of the experiments was to determine the influence of adding mushroom production waste and the preparation "Humostim" to greenhouse soil in specific proportions on the growth rate, biological indicators, and yield potential of cucumber seedlings. During the research, substrates prepared from a mixture of various components (80% and 90% mushroom waste, peat, and sand) were tested.





The experimental results demonstrated that the combined addition of mushroom production waste and the "Gumostim" preparation to greenhouse soil significantly increased the germination rate of cucumber seeds. In the average experimental variants, the seed germination rate was 8-12% higher. The best result was observed in the variant with 80% mushroom waste added, where the germination rate reached its peak on the sixth day. The seed germination rate by the seventh day increased to 98%, which is considerably higher than in the control variant.

The dynamics of seedling growth also showed positive changes. Particularly intensive plant growth was noted in the variant using a 90% mixture of fungal waste with the drug "Gumostim." In the experimental variants, the average growth rate reached 0.90-1.00 mm, while in the control group this indicator was only 0.68 mm. This indicates that the physiologically active substances of the preparation activated the growth processes of seedlings.

In addition, the preparation "Gumostim" and a mixture of fungal waste reduced the vegetation period of plants by 2-4 days, i.e., on average, fully formed seedlings were obtained within 32-34 days. This creates the possibility of accelerating the process of preparing new seedlings in greenhouse conditions and obtaining several harvests during the year. The highest indicators of biological resistance were also observed in the 5th and 6th variants of the experiment, i.e., when using 80% and 90% fungal waste and the drug "Humostim." In these variants, the overall survival rate of seedlings was significantly higher than in the control.

Analysis of the results showed that the most effective option was a mixture with the addition of 80% fungal waste + peat 10% + sand 10% + "Humostim" to the greenhouse soil. Seedlings grown in this composition over 32 days gave the most optimal results in terms of morphological and physiological indicators.

In general, the conducted research has proven that the integrated use of fungal waste and biostimulants contributes to improving the quality of cucumber seedlings, accelerating growth processes, and increasing the economic efficiency of greenhouse vegetable growing. This technology is based on the principles of environmentally friendly, economical, and waste-free production and is recommended for wide application in practical vegetable growing.

## **ENTRANCE**

One of the most important factors in human health and longevity is proper and balanced nutrition. The normal development of each organism, the effectiveness of work activities, and the stability of the immune system are directly related to the quality of food consumed by a person. Currently, in the context of scientific and





technological progress, as well as socio-economic changes, attention to the full-fledged nutrition of the population is increasing. Therefore, the correct organization of rational nutrition remains one of the most pressing issues facing modern science. Sufficient levels of proteins, fats, carbohydrates, vitamins, macro- and microelements, and biologically active substances ensure the normal course of metabolic processes in the human body. A deficiency of these substances can lead to the emergence of various diseases.

Vegetable growing plays an important role in meeting this need, in particular, growing vegetables in greenhouse conditions. Greenhouse technologies, which allow growing vegetable crops year-round, are of great importance today in meeting not only the domestic market, but also the needs of exports. With the help of heated greenhouses, it is possible to obtain fresh, vitamin-rich vegetable products in all seasons of the year. In this process, managing plant growth and development stages, forming optimal microclimate, as well as proper organization of agrotechnical measures are the key to achieving high yields [1,2].

Among vegetables grown in greenhouses, cucumber (*Cucumis sativus* L.) occupies a special place. It is widely used not only in the daily diet of the population, but also in the food industry. The cleansing, vitamin-rich, low-calorie properties of cucumbers make them an important product for human health. Therefore, the demand for growing cucumbers year-round is always high. However, obtaining a high yield largely depends on the quality of the seedlings. High-quality seedlings are the main factor determining the yield in the subsequent stages of plant development. Therefore, the development of technologies for the rapid, high-quality, and economically efficient cultivation of cucumber seedlings in greenhouse conditions is a pressing scientific and practical task [5,6].

In recent years, numerous studies have been conducted on optimizing the seedling growing process using various biostimulants, organic additives, and effective substrates. In particular, significant work is being carried out in the direction of developing environmentally friendly, waste-free technologies. One of them is the use of mushroom production waste as a substrate. These wastes contain a rich source of organic substances necessary for plant growth, and their reuse serves to maintain ecological balance and increase economic efficiency. By adding the preparation "Humostim" to this substrate, it is possible to accelerate the growth rate of cucumber seedlings, enhance their adaptability, and increase yield quality indicators [7,8].

The scientific novelty of the research lies in the fact that when growing cucumber seedlings, the use of fungal waste as an organic substrate and the addition of biologically active preparations to it is experimentally studied to increase the fertility





of greenhouse soil. This method not only establishes waste-free production but also allows for the efficient use of renewable resources in agriculture [9,10].

Thus, the main goal of the research is to determine the optimal composition of the substrate for growing cucumber seedlings in greenhouse conditions in the soil and climatic conditions of the Kibray district of the Tashkent region, to assess the dynamics of seedling growth, quality indicators, and the influence on yield in field conditions. This will create an opportunity to increase the efficiency of greenhouse vegetable growing and introduce environmentally friendly, economical, and sustainable technologies.

### **Materials and Methods**

Research work was carried out in greenhouse complexes of the educational and experimental farm of Tashkent State Agrarian University (TashGAU). The experiments were conducted during the growing season of 2018, and their main goal was to study the influence of increasing the biological activity of the soil composition, growth rates, and quality indicators of cucumber seedlings when growing them in greenhouse conditions by adding mushroom production waste and the preparation "Gumostim" in various ratios.

The experimental greenhouses were covered with glass, had a natural ventilation system, and the optimal microclimate conditions for plants (temperature 22-28°C, relative humidity 70-80%) were kept under constant control. The mechanical composition of the soil was light loamy, with a neutral or slightly alkaline environment (pH 6.9-7.2). For each experimental variant, an area of 10 m<sup>2</sup> was allocated, all variants were placed with three repetitions. This made it possible to ensure the statistical reliability of the experimental results.

The experiment was conducted on the basis of the field experiment method. In total, six different mixing options were studied in the scheme, the composition of which was as follows:

1. Chirin-di 20% + peat 70% + river sand 10% (control);
2. Mushroom waste 20% + peat 70% + river sand 10%;
3. Mushroom waste 40% + peat 50% + river sand 10%;
4. Mushroom waste 60% + peat 30% + river sand 10%;
5. Mushroom waste 80% + peat 10% + river sand 10%;
6. Mushroom waste 90% + peat 10%.



Each variant was evaluated under two different experimental conditions:

- Background 0 - without the drug "Humostim";
- Background 1 - with the drug "Humostim."

In the studies, a hybrid of the cucumber variety "Orzu" was used. This variety was selected because it is early-ripening, suitable for greenhouse conditions, and has a stable yield. Before sowing, the seeds were calibrated, disinfected, and sown at the same rate for each variant.

The organic mass remaining during the cultivation of *Agaricus bisporus* (white champignon) was used as a waste product of mushroom production. These wastes contain lignin, proteins, calcium, nitrogen, phosphorus, and trace elements, serving as a natural source of nutrients for the soil. Before adding them to the greenhouse substrate, they were dried, ground, and mixed with peat and river sand in specified proportions.

The preparation "Humostim" was used as a biologically active substance on the experimental substrates. It acts as a humor-based growth stimulant, accelerating root formation in plants, activating the process of photosynthesis, and increasing resistance to stress factors. The concentration of the working solution was 0.001%. The use of the drug was carried out in two stages:

1. Before sowing - the substrate was treated with a solution of "Humostim" (3-5 l/m<sup>2</sup>).
2. At the stage of seedling development - in the form of root feeding, 1-3 times every 14 days.

The total dose of the preparation used in the experiment was 3-10 l/m<sup>2</sup>. Along with the water, the solution was evenly absorbed.

The germination rate and germination percentage of cucumber seeds were compared in the variants with and without the "Gumostim" preparation. The appearance of the first seedlings, the duration of germination, and the percentage of total germination were determined. In addition, the dynamics of growth of biometric indicators of seedlings - stem length, number of leaves, leaf surface area, root length, and root mass - were regularly recorded. Measurements were taken every 10 days (on days 10, 20, and 30).

Biological resistance of seedlings was determined in laboratory and field conditions, the degree of plant survival, the degree of root system development, and the duration of the growing season were assessed. Based on the results of the observations, the average values for each variant were calculated and the level of statistical reliability was assessed using the method of variance analysis (ANOVA).

During the experiment, all agrotechnical measures were carried out under the same conditions: drip irrigation, temperature in the range of 22-28°C, and natural daylight.





The relative humidity inside the greenhouse was maintained at 70-80%. A digital thermohygrometer was used to monitor changes in temperature and humidity.

The data obtained at the end of the experiment were analyzed on the growth rate of cucumber seedlings, the percentage of germination, the duration of the growing season, and the degree of biological resistance. This made it possible to accurately compare the effectiveness of each substrate composition and assess the advantages of complex use with the drug "Humostim."

In experiments, fungal production waste is added to greenhouse soil with and without humus in various recommended proportions [11]. Their share in the total soil was 20-90%, and they were used as humus from production waste. The working solution of the Gumostim preparation, consisting of 0.001% humic acid, was applied to the soil: root feeding (irrigation of the greenhouse soil) in the germination phase of the seeds (or after transplanting the seedlings), then 1-3 times at intervals of 2 weeks. The application rate of humostim was 0.01% (humic acid) at a rate of 3-10 m<sup>2</sup> and the application rate of humic concentrate (1% humic acids - 3-10 ml m<sup>2</sup>).

### **Results obtained and their discussion**

Cucumber cultivation requires deep knowledge, on the basis of which it is possible to control the growth and development of crops and obtain high-quality vegetable products.

In the cultivation of cucumber seedlings, seed germination is the main factor. Analysis of the experimental variants showed that on the 6th day of the experiment, 81.5% of the seeds germinated, and the soil consisted of 80% fungal waste, while in the control, this indicator was 25.5%. (Fig. 1).

When using the fungal production waste in combination with the drug humostym, the germination of cucumber seeds increased by an average of 8-12%. The highest germination was observed in the variant treated with 80% of fungal production waste on the 6th day, and on the 7th day this indicator increased to 98%.

Thus, the best optimal soil was observed in the variant with the addition of 80% of fungal production waste and the drug humostym.



**Figure 1. Dynamics (changes) of cucumber germination**

1. Humus - 20% + peat 70% + river sand 10%;
2. Mushroom production waste 20% + peat 70% + river sand 10%;
3. Mushroom production waste 40% + peat 50% + river sand 10%;
4. Mushroom production waste 60% + peat 30% + river sand 10%;
5. Mushroom production waste 80% + peat 10% + river sand 10%;
6. Mushroom production waste 90% + peat 50%.



A standard cucumber seedling must be short and have an optimal number of leaves. When using cucumber seedlings in greenhouse soil with the addition of 80% fungal waste and the drug humostym, the growth rate ranged from 0.9 cm to 1 cm, and in the control it was 0.68 cm. (Fig. 2).

One of the important tasks in cucumber cultivation is obtaining a timely harvest, i.e., shortening the growing season of crops. The duration of the growing season is influenced by temperature and water regime (13-17, 14-20).

According to the research results, fungal production waste and humic preparations had a positive effect on the duration of the interphase period of seedlings (Table 1).

On average over the years, the interphase period - the first leaf in the experimental variants was 6-8 days at background 0. The shortening of this period with the administration of the drug Gumostim by variants was 1-2 days. In all experimental variants, the length of the growing season was in the range of 32-38 days. The shortest growing season, 32 days, was observed when growing cucumber seedlings in a medium with the addition of 80% of fungal waste to the greenhouse soil. The vegetation period was 2-4 days shorter compared to FON 0.

Experimental analysis showed that the seeds of the Orzu variety were of good quality. In laboratory conditions, germination was 99.6% (Table 2). In field conditions, germination was also high, but this indicator was not the same across the experimental variants. When using the preparation Gumostim, the germination rate of cucumber seeds in field conditions was higher by 2-12.5%. The highest biological resistance of seedlings was achieved with the addition of 80-90% of fungal waste during their cultivation and with the use of the drug humostym, and the germination rate was 97.1-97.2%.

Table 1 Duration of the interphase period of cucumbers

Experimental option	Period length, days						
	germination 1st leaf	1st leaf 2nd leaf	2nd leaf 3rd leaf	3rd leaf 4th leaf	4th leaf 5th leaf	5th leaf transplanting seedlings	Seedling growing season, days
Background 0 - Without adding and applying my Humostim							
Option 1	8	7	7	7	8	2	38
Option 2	6	7	7	8	8	1	36
Option 3	7	7	7	8	7	1	36
Option 4	7	6	8	7	7	1	36
Option 5	7	7	6	8	6	1	34
Option 6	6	7	7	7	5	1	36
Background 1 - Adding and supporting my Gumostim							
Option 1	6	7	8	7	8	2	35
Option 2	7	7	7	7	6	1	34
Option 3	6	8	7	7	5	1	34
Option 4	6	7	9	7	5	1	34
Option 5	6	5	7	7	5	1	32
Option 6	6	6	7	7	6	1	34



1. Humus - 20% + peat 70% + river sand 10%;
2. Mushroom production waste 20% + peat 70% + river sand 10%;
3. Mushroom production waste 40% + peat 50% + river sand 10%;
4. Mushroom production waste 60% + peat 30% + river sand 10%;
5. Mushroom production waste 80% + peat 10% + river sand 10%;
6. Mushroom production waste 90% + peat 50%.

Table 2 Biological resistance of cucumber seedlings

Experimental option	Vegetation period, days	Germination, %		Spacing of seedlings, thousand units/ha		
		Under laboratory conditions	In the field	In the germination phase	Before planting the seedling	
Background 0 - Without adding and applying my Humostim						
Option 1	38	99,6	81,0	56,7	52,08	8,1
Option 2	36	99,5	94,0	65,8	62,35	5,2
Option 3	36	99,5	95,5	66,85	63,49	5,0
Option 4	35	99,5	96,0	67,2	63,90	4,9
Option 5	34	99,5	96,5	67,55	64,65	4,3
Option 6	36	99,6	96,0	67,2	64,18	4,5
Background 1 - Giving and supporting my Gumos						
Option 1	35	99,0	93,5	65,45	62,81	4,1
Option 2	34	99,5	97,0	67,90	65,72	3,2
Option 3	34	99,5	97,0	67,80	65,74	3,2
Option 4	34	99,5	97,0	67,90	65,83	3,1
Option 5	32	99,5	98,0	68,6	66,71	2,8
Option 6	34	99,6	98,0	68,6	66,71	2,9

1. Humus - 20% + peat 70% + river sand 10%;
2. Mushroom production waste 20% + peat 70% + river sand 10%;
3. Mushroom production waste 40% + peat 50% + river sand 10%;
4. Mushroom production waste 60% + peat 30% + river sand 10%;
5. Mushroom production waste 80% + peat 10% + river sand 10%;
6. Mushroom production waste 90% + peat 50%.

The necessary biometric indicators for cucumber seedlings are stem height, its diameter, and the number of leaves. These indicators are essential for the process of photosynthesis.

The more rapidly the vegetative mass develops, the more correspondingly the process of photosynthesis proceeds. Ultimately, it influences flower formation and yield.

The most optimal cucumber seedlings were grown in 32 days. When adding humic preparations to greenhouse soil, their ratio was observed at a ratio of 80% of fungal waste + 10% of peat + 10% of river sand.



Table 3 Biometric indicators of cucumber seedlings of the Orzu variety

Experimental option	Stem length, cm	Stem diameter, ml	Number formed in plants		Seedling age, days
			Leaf, pcs	Bouquet, pcs.	
Background 0 - Without adding and applying my Humostim					
Option 1	25,1	5,8	4,9	15,7	38
Option 2	24,9	5,6	4,9	16,6	36
Option 3	24,4	5,4	5,0	17,6	36
Option 4	24,5	5,4	5,0	18,6	36
Option 5	23,8	4,9	5,1	19,5	34
Option 6	24,4	5,1	5,0	18,4	36
Background 1 - Giving and supporting my Gumos					
Option 1	35,8	5,6	5,0	19,7	35
Option 2	35,3	5,5	5,1	22,0	34
Option 3	34,9	5,4	5,2	22,8	34
Option 4	34,9	5,4	5,2	23,0	34
Option 5	32,1	4,9	5,3	24,0	32
Option 6	33,3	5,2	5,2	23,5	34

1. Humus - 20% + peat 70% + river sand 10%; 2. Mushroom production waste 20% + peat 70% + river sand 10%; 3. Mushroom production waste 40% + peat 50% + river sand 10%; 4. Mushroom production waste 60% + peat 30% + river sand 10%; 5. Mushroom production waste 80% + peat 10% + river sand 10%; 6. Mushroom production waste 90% + peat 50%.

The height of the seedling stems averaged 32.1 cm, the diameter averaged 4.9 ml, the number of formed leaves averaged 5.3 pieces, and flower buds 24 pieces. Thus, the addition of fungal production waste to the humin preparation made it possible to obtain high-quality cucumber seedlings.

## RESULT

The results of the conducted research showed that the combined use of mushroom production waste with the drug "Humostim" in the cultivation of cucumber seedlings has a positive effect on the development, biological resistance, and overall growth dynamics of the seedlings. During the experiment, it was established that the addition of fungal waste to the soil composition, especially in the 80 and 90 percent variants, improved the physicochemical properties of the soil, increased its air and water permeability, which ensured rapid and stable growth of seedlings.

The seed germination rate was 8-12% higher compared to the control variant. The highest germination was observed on the 6th day, reaching 98% in the soil variant



with the addition of 80% fungal waste. This result is explained by the combined effect of the physiological activity of the drug humostym and organic substances in fungal waste. These factors stimulated faster germination of seeds with energy, better development of the root system, and active metabolic processes in the early growth phase of the seedling.

It was noted that the growth rate of seedlings also increased in all experimental variants. If the growth rate in the control was on average 0.68 cm, then in the experimental variants this indicator reached 0.9-1.0 cm. This means an increase of 25-30%. Under the influence of the drug "Humostim," the root system actively grew, i.e., seedlings were able to quickly absorb nutrients from the soil. This condition enhanced the process of photosynthesis, improved the overall biometric indicators of the seedlings, and led to their healthy and uniform development.

The shortening of the growing season was also noted as an important scientific result. According to the results of the experiment, the growing season lasted 32-34 days, and in the variants with the use of the drug humostym, this period was reduced by 2-4 days. This makes it possible to accelerate the ripening of seedlings and obtain more rotating yields throughout the year.

The biological resistance of cucumber seedlings has also significantly increased. The highest indicators were found in the variants with the use of humostym with 80% and 90% fungal waste, which amounted to 97.1-97.2%. These indicators are associated with the anti-stress effect of humostim and the richness of fungal waste with natural humic substances. These factors increased the resistance of seedlings to changes in temperature and humidity, and strengthened their resistance to root inflammation and hardening diseases.

Even under background 0 (without humostimum), the influence of fungal waste was clearly felt, and seed germination on the 6th day was 81%, while in the control variant this indicator was only 16%. This result shows that the organic substances, nitrogen, phosphorus, and trace elements in the fungal waste increase the biological activity of the soil and improve the provision of plants with nutrients in the initial growth phase. Thus, the analysis confirms that the use of fungal production waste in combination with the drug humostym is one of the most effective methods for growing cucumber seedlings. The most optimal results were observed when applying humostim to the soil containing 80% fungal waste + 10% peat + 10% sand. In this case, the seedlings were stable, healthy, had a well-developed root system, and ripened within 32 days.

The conducted experiments provide valuable practical recommendations. Firstly, the processing of mushroom production waste and its use in agriculture is an environmentally friendly and cost-effective solution. Secondly, the use of humic





preparations increases soil fertility, accelerates the process of growing seedlings, and improves product quality. Thirdly, this method can be recommended as a resource-saving technology for farmers growing cucumbers in greenhouses.

In conclusion, it can be noted that the combined use of fungal waste with humostym not only increases the biological effectiveness of seedling cultivation, but also improves the natural structure of the soil, activates the cycle of organic matter, and contributes to the formation of an ecologically sustainable agricultural system. Therefore, the widespread introduction of this technology into practice is effective.

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