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Assessment of the Biotechnological Potential of Zoohumus in Dill Growing

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ABSTRACT

This research work presents scientific conclusions on the role of biological fertilizers in ensuring food security based on a sustainable agricultural system, their safety aspects, and the development and significance of non-traditional biological fertilizer biotechnology. The importance of zoohumus prepared on the basis of *the Tenebrio molitor* mealybug as a non-traditional biological fertilizer in the growth and development of the medicinal and aromatic dill sedge was demonstrated. In assessing the effect of zoohumus on the growth and development of sedge, cattle manure processed on the basis of earthworms, i.e. biohumus, was used as a control. Based on the research, it was shown that zoohumus retains nutrients that are easily absorbed by dills several times higher than biohumus. In particular, it was noted that zoohumus retains 0.77% more total $N\text{-}NH_4$ than biohumus. It was also found that the total P_2O_5 in zoohumus was 6.45% on average, which is 3.49% more than in biohumus. In addition, based on studies, it was noted that the total K_2O content of zoohumus was 3.44% on average, which is 3.49% more than in biohumus. It was also shown that the amount of mobile $N\text{-}NH_4$ in zoohumus was 362.28 mg/kg, which is 229.81 mg/kg more than in biohumus. The amount of mobile phosphorus (P_2O_5, mg/kg) was found to be 1150.18 mg/kg than in zoohumus and 294.2 mg/kg more than in biohumus. It was also shown that the amount of mobile potassium (K_2O) in zoohumus was 7166.82 mg/kg on average, which is 3061.17 mg/kg more than in biohumus. Also, the effect of zoohumus and biohumus on some biometric indicators and chlorophyll retention properties of Dill grown for 30 days was shown. Based on the results of the study, it was recommended to use zoohumus in agricultural practice as a more stable biological fertilizer than biohumus.

Introduction

One of the most important aspects of agrotechnology for the production of dill-based products is the determination of the role of fertilizers in obtaining organic products and, on this basis, the focus on obtaining organically pure products.

All types of fertilizers, including chemical fertilizers and biological fertilizers, each have their own advantages and disadvantages in providing dills or crops with essential nutrients, as well as in terms of environmental protection and the use of ecologically pure products (Chen, 2006).

In recent years, one of the most important tasks has been the widespread use of microbiological fertilizers based on microbial organisms that stimulate the dill root system and seed germination by converting nutrients in the soil into an easily digestible form, as well as the search for alternative options that can effectively replace traditional widely used biological fertilizers (biohumus, manure, humus fertilizer, liquid compost, biogas liquid fertilizer, etc.) and the assessment of their practical application (Nejatzadeh-Barandozi *et al.,* 2014).

Biological fertilizers are considered to be more environmentally friendly and effective than chemical fertilizers (Nejatzadeh-Barandozi, 2014; Elsen, 2000). However, the widespread use of biological fertilizers has several drawbacks from the perspective of ecology and environmental protection. In particular,

Firstly, livestock manure or its decomposed variants, along with their very high humus content, pose a great threat to ecology and environmental protection by containing various weed and weed seeds and various pathogenic microorganisms. In particular, decomposed manure and fertilizer products (various biofertilizers) imported from abroad can cause the widespread spread of weed and weed seeds, phytopathogenic microorganisms and their spores in agricultural lands. In particular, the presence of highly dangerous pathogenic microbes and their spores, such as *Listeria monocytogenes*, *Staphylococcus aureus* (Johannessen *et al.,* 2002), *Enterococcus faecium*, *E.faecalis*, *L.monocytogenes* (Johnston *et al.,* 2006), *Salmonella enterica* (Branquinho Bordini *et al.,* 2007), *Escherihia coli* O157:H7 (Beretti and Stuart, 2008), *E.coli* O104:H4 (Mellmann *et al.,* 2011), in such biological fertilizers also indicates a serious risk (Vassileva *et al.,* 2022). In this regard, it was found that the highly dangerous *E. coli* (STEC) O104:H4 toxin was found in the seeds of the medicinal dill *Trigonella foenum-graecum grown on cattle manure in Germany*, and 53 people died from its effects, and More than 800 people have been hospitalized, and similar cases have been reported in four other European countries, indicating that there is cause for concern (European Food Safety Authority, 2011).

Secondly, biofertilizers, which are processed with various types of earthworms and contain a high level of organic matter, especially humus, under the names of biohumus and vermicompost, are of great importance in agriculture (Qiamudin Abad, 2024). However, the fact that even in the composition of biological fertilizers of this type, weed seeds, as well as phytonematodes and phytopathogenic microflora and their spores are not rendered harmless (*Salmonella* spp., *Escherichia coli*., *Yersinia enterocolitica., Shigella., Clostridium perfringens and others*) indicates that they are not purely ecological products (Atanda *et al.,* 2018).

Thirdly, fertilizers based on residual waste from wastewater treatment dills are also widely used as biological fertilizers for agricultural crops. However, despite the richness of these biological fertilizers in various easily digestible nutrients and organic matter, safety issues remain open, depending on full compliance with technological processes during production. In particular, the widespread use of chemicals during wastewater treatment, especially chlorine and its derivatives, can lead to the instability of the chemicals contained in these fertilizers. Also, the incomplete destruction of vegetative cells of pathogenic and highly pathogenic microorganisms during wastewater treatment processes and the risk of their spores surviving require a deeper ecological study (Panikkar *et al.,* 2003).

Fourth, the use of microbiological fertilizers, which have become increasingly important in recent years in maintaining environmental sustainability, has become very important. Microbiological fertilizers play an important role in converting difficult-to-absorb nutrients in the soil into easily absorbed forms. The production of microbiological fertilizers is a relatively inexpensive, convenient and environmentally friendly method of production. Although it is questionable whether the above-mentioned biological fertilizers are purely ecological, their widespread use is important because it limits the possibilities of using chemical and mineral fertilizers (Sifolo *et al.,* 2018). Therefore, they are widely used.

Nevertheless, large-scale research is being conducted in world scientific sources to find and implement effective ways to use biological fertilizers as alternatives to animal manure, rotted manure, and biohumus. Therefore, the aim of this research was to study the chemical composition of zoohumus produced by foraging insects and its effect on dills. While the effect of biological fertilizers on dills has been studied very little in scientific sources, the effect of zoohumus has not been studied at all.

Materials and Methods

Research object and its brief description. The Alligator variety of Dille *Anethum graveolens* L was used as the research object.

Biological fertilizers: Zoohumus: Zoohumus prepared during the reproduction of larvae of the food insect *Tenebrio molitor in a standard nutrient medium* in the scientific laboratory of the Tashkent Institute of Chemical Technology, Department of "Biotechnology" was used as a biological fertilizer. Zoohumus was presented by S. Salomova, an independent researcher at Karshi State University (2023-2025). Biohumus was prepared at the TKTI, Department of "Biotechnology", and biohumus was prepared on the basis of Californian earthworms grown on humus based on cattle manure and tree leaves.

Chlorophyll a and b: This method is based on extracting leaves using the organic solvent acetone and calculating the amount of chlorophyll *a* and *b* fractions with a spectrophotometer at the appropriate wavelengths (Tret'yakov *et al.,* 1990).

Six leaves are cut, crushed, mixed and three samples of 200 mg are taken on an analytical balance. The samples are ground in a mortar with the addition of $CaCO_3$ 80% acetone is added little by little and extracted until homogeneous. The substance is quantitatively transferred to Shot filters marked No. 3 and No. 4 and filtered through a vacuum pump into a Bunsen flask, thoroughly washing the pigments with acetone. For easy filtration of the filtrate, a 20 ml test tube is installed in the flask. Then the filtrate is taken from the test tube to a 50 ml flask and brought to the required volume and the wavelength (*for chlorophyll "a"* – e_{663}, or D_{665}, for chlorophyll "*b") is determined. For chlorophylls* a and b, the extinction (E) or light absorption (D) values are determined in a spectrophotometer at wavelengths of ε_{645} or D_{649}.

The calculation is carried out according to the following formulas: $C_a = 12.7\ e_{663} - 2.69\ e_{645}$; $S_b = 22.9\ e_{645} - 4.63\ e_{663}$; $S = C_a + S_b = 8.02\ e_{663} + 20.2\ e_{645}$ or $S_a = 11.63\ D_{665} - 2.39\ D_{649}$; $C_b = 20.11\ D_{649} - 5.18\ D_{655}$; $C_{a+b} = 6.45\ D_{665} + 17.72\ D_{649}$.

C_a – chlorophyll *concentration of a*; S_b - k chlorophyll *concentration b*

S - chlorophyll *a* and *b is the concentration of the aggregate.*

Chlorophyll concentration is calculated in mg/l. The following formula was used to calculate the concentration of pigments per gram of wet matter:

$$M_{chlorophyll} = \frac{K \times V}{P}$$

K — this is S_a, S_b or S; *V* - dilution volume; *R* – sample weight 0.2 g.

The amount of chlorophyll can be calculated by knowing the percentage of dry matter in leaves.

Analysis of chlorophyll retention indices

Determined according to standard methods provided for research by Alain Aminot and Francisco Rey (2000). In particular, the following standard unit indices were adopted for the research:

The spectrophotometric →trichromatic method (Alain Aminot *et al.,* 2000):

Chlorophyll a = (11.85* (E664-E750)-1.54* (E647-E750)-0.08 (E630-750))*Ve/L*Vf;

Chlorophyll b = (-5.43* (E664-E750)+21.03* (E647-E750)-2.66 (E630-E750))*Ve/L*Vf;

Chlorophyll c = (-1.67* (E664-E750)-7.60* (E647-E750)+24.52 (E630-E750))*Ve/L*Vf;

Where: L is the light path of the cuvette, in centimeters; Ve is the extraction volume in milliliters; Vf is the total filtered volume in liters; concentrations are taken in units of mg $m^{-3.}$

Monochromatic method by spectrophotometry acidification → (Alain Aminot *et al.,* 2000):

Chlorophyll a = 11.4*K*((E665o - e750o) - (E665a -

e750a))*Ve /L*Vf;

Pheopigments a = 11.4*K*((R*(E665a − e750a)) − (E665o − e750o))*Ve /L*Vf;

Where: L is the light path of the cuvette, in centimeters; Ve is the extraction volume in milliliters; Vf is the filtered volume in liters; Concentrations are taken in units of mg $m^{-3.}$

Fluorometry method (Alain Aminot *et al.,* 2000):

Chlorophyll a = K*(Fm/(Fm − 1))* Ve *(Fo − Fa)/Vf

Phaeopigments a = K*(Fm/(Fm − 1))* Ve *((Fm*Fa) − Fo)/Vf

Where: K= calibration coefficient = µg CHl a ml, fluorescence unit of the instrument for 90% acetone.

Fm = maximum acid ratio (Fo/Fa) of the pure chlorophyll a standard.

Fo = sample fluorescence before acidification.

Fa = fluorescence index of the sample after acidification.

Ve = extraction volume in milliliters.

Vf -filtered volume in liters;

Concentrations were obtained in units of mg $m^{-3.}$

Slope indicators. Calculated using the following formula using the international standard ISO 3632 (ISO 3632, 1993):

$$E^{\%} = \frac{A \times 2000}{100 - h}$$

Here: A=absorption, h=humidity, %.

Results and Discussion

Analysis of the chemical composition of conventional and non-conventional biological fertilizers

The studies studied the analysis of the main chemical composition of traditional biohumus and non-traditional zoohumus. The results obtained are reflected in Table 1.

When comparing the results obtained in Table 1, it can be seen that the chemical composition of biohumus showed different indicators. In the studies conducted on the basis of zoohumus, the average humus content observed in 5 variants was 56.64%, which was 28.17% more humus than biohumus. In particular, in the 1st variant based on zoohumus, the humus content was 56.89%, in the 2nd variant it was 57.48 %, in the 3rd variant it was 56.53%, in the 4th and 5th variants it was 56.68 and 56.42%, respectively. It was noted that the relatively small differences in these variants can be explained by the fact that the zoohumus was obtained from different batches of the same material and by small errors in the research. When comparing the results obtained in biohumus, it was found that the average humus content was 28.47%. The humus content in biohumus was 28.21% in variant 1 It was found that it was 29.26% in the 2nd option, 28.43% in the 3rd option, 29.12% and 27.82% in the 4th and 5th options.

Studies conducted in zoohumus, the total $N\text{-}NH_4$ % content The average value of 1.22% was found in 5 variants, which is 0.77% higher than in biohumus. In variant 1 of zoohumus, the total $N\text{-}NH_4$ content was 1.16%, while in variant 2 it was 1.28%, in variant 3 it was 1.24%, in variant 4 it was 1.18%, and in variant 5 it was 1.26%. The total $N\text{-}NH_4$ % in biohumus was found to be 0.44% in variant 1, 0.46% in variant 2, 0.46 and 0.44% in variants 3 and 4, respectively, and 0.45% in variant 5.

From the table above, it was found that the total P_2O_5 % in the 5 variants of zoohumus was 6.45% on average, and the total P_2O_5 % was 3.49% higher than in biohumus. In the 1st variant of zoohumus, the total P_2O_5 % was 6.84%, in the 2nd variant it was 5.92%, in the 3rd variant it was 5.89%, and in the 4th and 5th variants the indicator was found to be 6.82 and 6.78%, respectively. When comparing the total P_2O_5% of biohumus, it was found to be 2.71% in the 1st variant, 2.83% in the 2nd variant, 2.92% in the 3rd variant, 3.12% in the 4th variant, and 2.96% in the 5th variant.

Total potassium (K_2O)% in the 5 zoohumus variants obtained was found to be 3.44%, which is 3.49% higher than the total K_2O% in the biohumus samples. In particular, in the zoohumus-based variant 1, the total K_2O% was 3.25%, in the variant 2 it was 3.62%, in the variant 3 it was 6.42%, in the variant 4 it was 3.36%, and in the variant 5 it was 3.56%. It was noted that the average total K_2O% of biohumus was 1.97%, with 1.94%

in option 1, 1.89% in option 2, 2.14% in option 3, 1.92% in option 4, and 1.98% in option 5.

Mobile N-NH_4 mg/kg in zoohumus samples was found to be 362.28 mg/kg, which is 229.81 mg/kg higher than in biohumus. In zoohumus, the amount of mobile N-NH_4 mg/kg was observed at values of 362.16; 363.14; 368.24; 359.49; 358.36, respectively. In biohumus samples, this indicator was found to be 132.47 mg/kg on average, which is 108.81; 142.36; 162.28; 112.42; 136.48, respectively.

The average value of mobile phosphorus (P_2O_5, mg/kg) in zoohumus samples was 1150.18 mg/kg, which was 855.98 mg/kg higher than the 294.2 mg/kg in biohumus. It was noted that in variant 1 of zoohumus it was 1134.46 mg/kg, in variant 2 it was 1176.28 mg/kg, in variant 3 it was 1162.36 mg/kg, in variants 4 and 5 it was 1129.48 and 1148.34 mg/kg, respectively. In biohumus samples, this indicator was 314.24 mg/kg, 274.48 mg/kg, 311.28 mg/kg, 286.68 mg/kg, 284.32, respectively.

When comparing the results obtained in Table 1, it was found that the average amount of mobile potassium (K_2O) observed in the 5 variants of studies based on zoohumus was 7166.82 mg/kg, which is 3061.17 mg/kg more than in biohumus. In particular, in the 1st variant based on zoohumus, the amount of mobile potassium (K_2O) was 6985.15 mg/kg, in the 2nd variant it was 6649.23 mg/kg, in the 3rd variant it was 6819.18 mg/kg, in the 4th variant it was 7598.21 mg/kg, and in the 5th variant it was 7782.31 mg/kg. When comparing the results obtained in biohumus, it was found that the average amount of mobile potassium was 4105.65 mg/kg. In the biohumus-based variant 1, the amount of mobile potassium (K_2O) was 4428.22 mg/kg, in the variant 2 it was 3638.18 mg/kg, in the variant 3 it was 4323.36 mg/kg, in the variant 4 it was 3886.12 mg/kg, and in the variant 5 it was 4252.36 mg/kg.

Comparing the moisture content of zoohumus and biohumus, we can see that zoohumus has an average of 13.77 and biohumus has an average of 20.85, and zoohumus >7.08 has a lower moisture content. In particular, it was found that zoohumus was 13.32 in the 1st option, 13.46 in the 2nd option, 14.28 in the 3rd option, and 13.32 and 14.46 in the 4th and 5th options, respectively. It was determined that the moisture content of 5 versions of biohumus is 20.82, 21.48, 20.46, 20.67, 20.81.

When comparing the results obtained in Table 1, it can be seen that the pH value in the composition of biological fertilizers also showed different values. In studies conducted on the basis of zoohumus, it was found that the average pH value observed in 5 variants was 6.92, which is 0.19 higher than that of biohumus. In particular, in the 1st variant based on zoohumus, the pH value was 7.04, while in the 2nd variant it was 7.08, in the 3rd variant it was 6.49, in the 4th and 5th variants it was 7.02 and 6.96, respectively.

When comparing the results obtained in biohumus, it was found that the average pH value was 6.73. The pH values of the biohumus samples were 6.72 in option 1, 6.74 in option 2, 6.74 in option 3, 6.72 in option 4, and 6.71 in option 5, respectively. During the studies, it was noted that the environmental parameters of both biological fertilizers were within normal limits.

The effect of biological fertilizers on the growth of Dill.

Table 2 shows the effect of biofertilizers on the growth of Dill. It was noted that the germination of seedlings on the 7th day when using 6 variants of zoohumus was 7.045% on average, when using biohumus this indicator was 2.91%, and it was 4.12% less than zoohumus (Table 2).

When 0.5 (5 t/ha) of zoohumus was used, the germination of seedlings on the 7th day was 7.12%, on the 10th day the germination was 24.36%, on the 13th day the germination was 54.14%, on the 17th day the germination was 12.36%, 97.98% of the seeds germinated, and the average germination the loss rate was noted to be 2.02%. When zoohumus was applied in the amount of 1.0 (10 t/ha), germination was 5.42% on the 7th day, 27.24% on the 10th day, 38.12% on the 13th day, and 18.14% on the 17th day.

The total seed germination was 98.52%, and the loss rate was 2.46%. In 1.5 (15 t/ha) zoohumus, it was 5.31% on the 7th day, 26.36% on the 10th day, 28.45% on the 13th day, and 24.34% on the 17th day. This amount of zoohumus was also effective, 94.46% total fertility was achieved, and the loss was 5.22%. 8.18% on the 7th day, 22.26% on the 10th day, 37.12% on the 13th day, and 23.16% on the 17th day were recorded when 2.0 (20 t/ha) zoohumus was applied. The loss was 9.28%. In 2.5 (25 t/ha) zoohumus, it was 8.42% on the 7th day, 23.18% on the 10th day, 32.43% on the 13th day, 23.36% on the 17th day, and the loss rate was 12.61%. When 3.0 (30 t/ha) zoohumus was applied, it was 7.82% on the 7th day, 22.34% on the 10th day, 41.22% on the 13th day, 14.21% on the 17th day, and the loss rate was 14.41%.

When 6 variants of biohumus were used, germination rates of seedlings were lower compared to zoohumus. In particular, when 0.5 (5 t/ha) amount of biohumus was used, it was 1.22% on the 7th day, 12.11% on the 10th day, 21.12% on the 13th day, and 32.35% on the 17th day. In this variant, the total germination of seeds was 97.95%, and the loss rate was 2.05%. In 1.0 (10 t/ha) biohumus, it was 2.06% on the 7th day, 11.02% on the 10th day, 29.04% on the 13th day, and 36.19% on the 17th day (Table 2). Although productivity is high, the loss is 3.57%. Indicators in 1.5 (15 t/ha) biohumus: 2.67% on the 7th day, 14.28% on the 10th day, 33.42% on the 13th day, 36.23% on the 17th day. The loss rate was 5.24%. 2.0 (20 t/ha) biohumus showed 3.21% on the 7th day, 16.17% on the 10th day, 25.12% on the 13th day, and 32.22% on the 17th day. The loss rate was 15.12%. In 2.5 (25 t/ha) biohumus, 4.17% on the 7th day, 22.36% on the 10th day, 32.11% on the 13th day, 13.08% on the 17th day, and the loss was 22.12%. In 3.0 (30 t/ha) biohumus, it was 4.18% on the 7th day, 24.14% on the 10th day, 26.36% on the 13th day, 15.62% on the 17th day, and the loss rate was 23.42%.

When analyzing the results presented in Table 2, it was noted that the application of various doses of zoohumus had a positive effect on the germination process of seedlings. In particular, at a dose of 0.5 kg/m² (5 t/ha), germination on day 7 was 7.12%, which is significantly higher than all biohumus variants (for example, only 1.22% at 0.5 kg/m²). By day 10, germination in zoohumus variants was around 22–27%, with the highest indicator of 27.24% (1.0 kg/m²). By day 10, the result in the biohumus 1.0 kg/m² variant was almost twice as high as (11.02%). By the 13th day of application of zoohumus at a rate of 0.5 kg/m², germination was 54.14%, which was higher than all biohumus and zoohumus variants. By the 17th day of observation, the highest indicators (24.34% and 23.16%) were recorded when applying zoohumus at a rate of 1.5 and 2.0 kg/m². As the amount of biohumus increased, germination indicators decreased. At the same time, when the average loss in germination was also analyzed, losses when applying zoohumus at a rate of 0.5 kg/m² amounted to 2.02%, that is, the lowest loss indicator was achieved. When applied to biohumus, the average loss rate was higher, for example, at 2.0 kg/m² it was 15.12%, and at 3.0 kg/m² it increased to 23.42%.

In the control (NPK - at the recommended rate) variant, seedling germination was lower than in the biohumus and zoohumus variants. Although data up to day 7 were not recorded in this variant, germination on day 10 was 8.11%, on day 13 it was 18.12%, and on day 17 it was 27.21%. Based on these indicators, it can be seen that the germination rate was significantly slower than in the zoohumus and biohumus variants. At the same time, the level of total germination loss was one of the highest indicators, amounting to 14.36%.

According to the results of the experiment, significant differences were observed in the average length of seedlings due to the effects of zoohumus and biohumus fertilizers. In the variants where biohumus was used, the growth of seedlings was relatively low, while stable growth and high indicators were noted in zoohumus. With an increase in the amount of biohumus from 0.5 kg/m² to 3.0 kg/m², the average length of seedlings first increased and then decreased. In particular, although biohumus in the amount of 1.5 kg/m² showed the highest result with a length of 14.18 cm, at a dose of 3.0 kg/m² this indicator decreased to 12.13 cm.

This can be explained by the fact that excessive use of biohumus causes physiological stress or negative effects on dill development. In the variants where zoohumus was used, the growth of seedlings was both stable and high. At doses ranging from 0.5 kg/m² to 1.5 kg/m², the seedling length was around 15 cm, with the highest indicator at 1.0 kg/m² being 15.42 cm. Although a decrease in growth was observed at doses of 2.0 kg/m² and above, it can be seen that these indicators are still higher than those of biohumus and the control group. In the control (traditional NPK fertilizer) variant, the seedling length was much lower.

The result was about two times less than that of zoohumus, and much lower than the lowest indicator of biohumus. This clearly shows that the effect of biofertilizers, especially zoohumus, on the growth of Dill is more effective than that of chemical fertilizers. In conclusion, the amount of zoohumus at 1.0–1.5 kg/m² was the most effective amount in increasing the length of seedlings, and biohumus also had a certain effect in moderate doses.

According to the results of the experiment, the following main indicators were analyzed to assess the seed-bearing potential of dills in the biohumus, zoohumus and control (NPK) variants: Number of seed pods per dill (units);

Number of pods per pod (units); Weight of 1000 seeds (in grams). It was noted that in the biohumus variants, the average number of seed pods per dill ranged from 10.12 to 14.18 (maximum 1.5 kg/m²). The shubu index in zoohumus variants is on average 15.23 pieces when 0.5 (5 t/ha) is used, 15.42 pieces when 1.0 (10 t/ha) is used, 15.31 pieces when 1.5 (15 t/ha) is used, 14.26 pieces when 2.0 (20 t/ha) is used, 2.5 (25 t/ha) and 3.0 (30 t/ha) and 13.18 and 12.24 pieces were recorded, respectively.

In the control variant, the number of seed pods was 7.36. When biohumus was used, the number of pods in the pods was observed from 22.14 to 28.32 (maximum 2.0 kg/m²), and the weight of 1000 seeds was recorded from 1.34 g to 1.43 g (maximum 3.0 kg/m²). In the zoohumus variants, the number of pods in the pods was recorded from 20.08 to 32.18 (maximum 0.5 kg/m²), and the weight of 1000 seeds was recorded from 2.02 g to 2.44 g (maximum 1.0 kg/m²). In the control (NPK) variants, the number of pods in the pods was 17.22, and the weight of 1000 seeds was 1.26 g.

Effect of biological fertilizers on some biometrical parameters and chlorophyll storage of Dill

Table 3 shows the effects of conventional and non-conventional biological fertilizers on some biometric parameters and chlorophyll production as a result of the effects of medicinal and spice sedum dill.

The average length of seedlings in 30-day-old dills of all variants of zoohumus was 24.36 cm long, and this indicator was 21.43 cm in biohumus variants (Table 3). In particular, when using 6 variants of zoohumus, the length of seedlings was 21.95 cm in 30 days when 0.5 (5 t/ha) of seedlings was used, 23.95 cm when 1.0 (10 t/ha) of zoohumus was used, 23.95 cm when 1.5 (15 t/ha) of zoohumus was used, 2.0 (20 t/ha) of zoohumus 25.03 cm when applied, 2.5 (25 t/ha) zoohumus was recorded 23.65 cm. When 13.0 (30 t/ha) zoohumus was applied, it was 23.65 cm long. When biohumus was used, the growth rate was lower compared to zoohumus and the effect was observed later. The 30-day shoot length was 17.76 cm at 0.5 kg/m², and the highest value was 25.53 cm at 3.0 kg/m². It can be seen that the effect of zoohumus is more pronounced in high doses. The average number of branches in seedlings in all variants using zoohumus was 4.71 units, while in biohumus variants this indicator was 3.95 units on average.

In particular, 6 variants of different amounts of zoohumus showed the following results: When zoohumus was applied at 0.5 kg/m² (5 t/ha), the average number of shoots per seedling was 4.43. 4.56 units when applied at the rate of 1.0 kg/m² (10 t/ha). When 1.5 kg/m² (15 t/ha) of zoohumus was used, 5.08 branches were recorded, which is the highest indicator. It was 5.01 when applied at 2.0 kg/m² (20 t/ha). At 2.5 kg/m² (25 t/ha), this indicator was 4.86 units.

When 3.0 kg/m² (30 t/ha) of zoohumus was used, 4.32 branches were recorded. In all options where biohumus was used, the average number of shoots in seedlings was 3.95, which is a lower result compared to zoohumus. In particular, 6 variants with different amounts of biohumus showed the following results. When applied at the rate of 0.5 kg/m² (5 t/ha), the average number of branches per dill was 3.44. At 1.0 kg/m² (10 t/ha) — 4.02 units. When using biohumus in the amount of 1.5 kg/m² (15 t/ha) — 4.21 units. At 2.0 kg/m² (20 t/ha), this figure was 3.98 units.

At 2.5 kg/m² (25 t/ha) — 3.66 units. When applying 3.0 kg/m² (30 t/ha) of biohumus, 3.37 shoots were recorded in the seedlings. The variants of zoohumus with a dose of 1.5 kg/m² and 2.0 kg/m² gave the highest number of shoots (5.08 and 5.01). The best result when applying biohumus was at 1.5 kg/m² (4.21 shoots), but a decrease was observed at subsequent doses.

When using zoohumus, the average weight of 30-day wet seedlings of Dill was 27.29 g/dill to 29.94 g/dill. The highest rate was observed when 1.5 (15 t/ha) was applied (29.84 g/dill). In biohumus variants, these parameters were observed from 22.08 g to 26.88 g. The highest rate (26.88 g) was observed when 1.5 (15 t/ha) biohumus was applied. In the control variant, this indicator was the lowest, 21.86 g.

When using zoohumus, the average dry weight of the dill ranged from 1.64 g to 2.04 g, and the moisture content was maintained from 6.00% to 7.70%. The best indicator was recorded when using 0.5 (5 t/ha) zoohumus.

When using 3.0 (30 t/ha) zoohumus, the dry weight was 2.04 g (7.70%), which indicates that the dills lost more moisture than other options. The dry weight of the seedlings in the options under the influence of biohumus was from 1.38 g to 1.86 g, and the moisture content was maintained from 6.02% to 8.40%.

Table.1 Analysis of the main chemical composition of traditional biohumus and unconventional zoohumus

Variants No.	Examples	Humus, %	Total, %			Active, mg/kg			Humidity	pH
			$N\text{-}NH_4$	P_2O_5	K_2O	$N\text{-}NH_4$	P_2O_5	K_2O		
1	Biohumus	28.21±0.13	0.44±0.06	2.71±1.03	1.94±0.08	108.81±1.32	314.24±1.03	4428.22±1.27	20.82	6.72
2		29.26±0.08	0.46±0.08	2.83±0.08	1.89±0.06	142.36±1.11	274.48±0.98	3638.18±1.12	21.48	6.74
3		28.43±0.18	0.47±0.04	2.92±1.13	2.14±1.03	162.28±1.27	311.28±1.21	4323.36±0.98	20.46	6.74
4		29.12±0.06	0.46±0.06	3.12±1.08	1.92±0.04	112.42±0.09	286.68±0.84	3886.12±1.13	20.67	6.72
5		27.82±0.21	0.44±0.08	3.21±0.09	1.98±0.06	136.48±1.18	284.32±0.82	4252.36±1.08	20.81	6.71
Average indicator		28.47±0.13	0.45±0.06	2.96±0.68	1.97±0.25	132.47±1.02	294.20±0.98	4105.65±1.11	20.85	6.73
1	Zoohumus	56.89±0.28	1.16±0.18	6.84±0.08	3.25±0.04	362.16±1.06	1134.46±1.07	6985.15±0.96	13.32	7.04
2		57.48±1.08	1.28±0.04	5.92±1.03	3.62±0.06	363.14±0.92	1176.28±1.02	6649.23±1.03	13.46	7.08
3		56.23±1.11	1.24±0.64	5.89±0.86	3.42±0.04	368.24±0.84	1162.36±0.98	6819.18±1.08	14.28	6.49
4		56.18±0.08	1.18±0.18	6.82±1.08	3.36±0.08	359.49±1.03	1129.48±0.86	7598.21±0.98	13.32	7.02
5		56.42±1.06	1.26±0.08	6.78±0.43	3.56±0.03	358.36±0.98	1148.34±0.88	7782.31±0.82	14.46	6.96
Average indicator		56.64±0.72	1.22±0.37	6.45±0.49	3.44±0.05	362.28±0.96	1150.18±0.96	7166.82±0.97	13.77	6.92

Note: Each variant was determined in triplicate, p -0.05

Table.2 The effect of biological fertilization on the growth and development of Dill

Experience examples	Fertilizers used quantity	Seedlings days in the section dry output, %					Average in memory loss indicator, %	Seedlings average length, cm		30 days average growth indicator, cm	A seed in a dill number of umbrellas **, pcs	A piece of umbrella number of umbrellas **, pcs	1000 seeds weight, g
		7	10	13	17	21		On the 60th day of cultivation	Harvest from collecting before, mature dill (90 days)				
Biohumus, kg/m²	0.5 (5 t/ha)	1.22	12.11	21.12	32.35	31.15	2.05	58.48	122.42	63.94	10.12	22.14	1.34
	1.0 (10 t/ha)	2.06	11.02	29.04	36.19	18.12	3.57	62.28	124.12	61.84	10.22	24.22	1.36
	1.5 (15 t/ha)	2.67	14.28	33.42	36.23	8.16	5.24	64.46	126.23	61.77	14.18	28.18	1.36
	2.0 (20 t/ha)	3.21	16.17	25.12	32.22	8.16	15.12	72.22	128.47	56.25	14.08	28.32	1.35
	2.5 (25 t/ha)	4.17	22.36	32.11	13.08	6.16	22.12	84.36	136.12	51.76	12.06	22.14	1.42
	3.0 (30 t/ha)	4.18	24.14	26.36	15.62	6.28	23.42	82.86	132.41	49.55	12.13	22.26	1.43
Zoohumus , kg/m²	0.5 (5 t/ha)	7.12	24.36	54.14	12.36	-	2.02	72.52	151.32	78.8	15.23	32.18	2.32
	1.0 (10 t/ha)	5.42	27.24	38.12	18.14	8.62	2.46	78.48	154.24	75.76	15.42	32.14	2.44
	1.5 (15 t/ha)	5.31	26.36	28.45	24.34	10.32	5.22	82.23	148.36	66.13	15.31	30.36	2.22
	2.0 (20 t/ha)	8.18	22.26	37.12	23.16	-	9.28	86.14	148.22	62.08	14.26	26.42	2.13
	2.5 (25 t/ha)	8.42	23.18	32.43	23.36	-	12.61	86.28	152.14	65.86	13.18	22.14	2.08
	3.0 (30 t/ha)	7.82	22.34	41.22	14.21	-	14.41	85.14	154.56	69.42	12.24	20.08	2.02
Control (NPK - recommendation done norm *)	150:200:100	-	8.11	18.12	27.21	32.20	14.36	56.12	114.34	58.22	7.36	17.22	1.26

Note- *- Walid S. Nasir., 2021 (ammonium sulfate -N-20.5%; calcium superphosphate -P_2O_5-15.5%; potassium sulfate -K_2O-48.5%. **- Based on 100 dills) P-0.05; Seeds were sown without soaking.

Table.3 Effect of biofertilization on biometric parameters and chlorophyll production (30 days) of chives

Experience examples	Fertilizers used quantity	Nihal's average length , cm	In the nursery average number of branches , pcs	Nihal's average weight , g/ dill		Amount of chlorophyll in leaves , mg/g	
				wet seedling	dry seedling	chlorophyll A	chlorophyll B
Biohumus, kg/m²	0.5 (5 t/ha)	17.76	3.44	22.84	1.38	1.43	0.38
	1.0 (10 t/ha)	18.25	4.02	26.71	1.61	1.50	0.40
	1.5 (15 t/ha)	18.67	4.21	26.88	1.83	1.78	0.44
	2.0 (20 t/ha)	23,24	3.98	23.64	1.86	1.57	0.46
	2.5 (25 t/ha)	25.14	3.66	22.86	1.86	1.71	0.45
	3.0 (30 t/ha)	25.53	3.37	22.08	1.86	1.60	0.51
Zoohumus , kg/m²	0.5 (5 t/ha)	21.95	4.43	27.29	1.64	1.60	0.46
	1.0 (10 t/ha)	23.97	4.56	28.22	1.78	1.63	0.49
	1.5 (15 t/ha)	27.93	5.08	29.84	1.92	1.58	0.46
	2.0 (20 t/ha)	25.03	5.01	28.66	1.92	1.60	0.49
	2.5 (25 t/ha)	23.64	4.86	28.34	1.98	1.59	0.46
	3.0 (30 t/ha)	23.65	4.32	26.27	2.04	1.57	0.43
Control (NPK)	150:200:100	16.01	3.43	21.86	1.32	1.33	0.37
P-0.05							

The most optimal option for biohumus can be indicated as 1.0 (10 t/ha). The highest loss was observed when 3.0 (30 t/ha) biohumus was applied. When the control (NPK) was applied, the parameters were 1.32 g dry sprout weight and 6.04% moisture retention.

The amount of chlorophyll A in leaves was 1.59 mg/g, and the amount of chlorophyll B was 0.465 mg/g in all variants using zoohumus. In particular, when applied in the amount of 0.5 kg/m², chlorophyll A was 1.60 mg/g and chlorophyll B was 0.46 mg/g. At 1.0 kg/m², chlorophyll A was 1.63 mg/g and B was 0.49 mg/g. A 1.58 mg/g and B 0.46 mg/g at 1.5 kg/m², A 1.60 mg/g and B 0.49 mg/g at 2.0 kg/m², A 1.59 mg/g and B 0.46 mg/g at 2.5 kg/m², and A 1.57 mg/g and B 0.43 mg/g at 3.0 kg/m² was determined. These results showed that zoohumus increased the chlorophyll content consistently and stably, especially the most effective results were recorded at 1.0–2.0 kg/m².

In biohumus variants, the amount of chlorophyll A and B changed differently compared to zoohumus, and it was more strongly manifested in higher amounts. In particular, at 0.5 kg/m², chlorophyll A is 1.43 mg/g, B is 0.38 mg/g; A 1.50 mg/g, B 0.40 mg/g at 1.0 kg/m²; A 1.78 mg/g, B 0.44 mg/g at 1.5 kg/m²; A 1.57 mg/g, B 0.46 mg/g at 2.0 kg/m²; At 2.5 kg/m² A 1.71 mg/g, B 0.45 mg/g and at 3.0 kg/m² A 1.60 mg/g, B 0.51 mg/g were observed. In particular, the application of biohumus at 1.5 kg/m² resulted in the highest level of chlorophyll A - 1.78 mg/g, and at 3.0 kg/m², chlorophyll B reached 0.51 mg/g. This shows that biohumus has a strong effect in increasing photosynthetic activity in high amounts.

In recent years**,** new production sectors have emerged in order to ensure food security, increase the range of agricultural products, and effectively use natural food and feed products.

One of these new sectors is the widespread use of food insects for the production of various products for various sectors of the economy, including agriculture, food, medicine, and pharmaceuticals.

Large-scale insect farms have emerged based on the cultivation of food insects on a large scale. As a result, the excrement produced by insects during their reproduction, i.e., large amounts of fertilizer, i.e., zoohumus, are produced by them. These zoohumus are distinguished by the fact that they do not contain seeds of alien and wild weeds, do not contain pathogenic microflora and their spores, depending on nutrition, and contain several times more nutrients than biohumus. This is also noted as another new type of biological fertilizer.

Scientific sources have studied the effect of zoohumus on the medicinal dill saffron, and it was found that it leads to the synthesis of more biologically active substances than biohumus (Nodira K. Ruzmetova *et al.,* 2024).

However, there is a lack of information on the use of zoohumus in the cultivation of agricultural crops and the development of its norms and necessary agrotechnologies. This research is characterized by the fact that it is a preliminary scientific work. Based on the results of this study, it is recommended to use zoohumus in agricultural practice as a more stable biological fertilizer than biohumus.

Scientific sources show that the yield of chives in the technology of cultivation is determined by several factors (Carrubba *et al.,* 2011). Also, the effectiveness of fertilizers used in the process of cultivation of chives is characterized by the initial use of chives. In particular, when using chives as greens, it is measured by the number of times they are harvested per season and the total fresh mass yield.

In addition, when grown for its seed (grains), the yield of the dill is measured by the number of seed pods, the number of pods in the seed pod, and the total grain yield. In this case, the dry biomass of the dill (straw) remaining after harvesting the seed (seeds) of the dill is also evaluated, and the straw yield is also important as a measure of production productivity.

Typically, rye straw (dried leaves and stalks) is left on the cultivated area as green manure, i.e. siderate fertilizer. The main reason for this is that rye straw decomposes quickly and easily in the soil, and it contains a high level of organic acids, magnesium, and calcium.

In recent years, the use of a herbal infusion of arable land and its use as a liquid biological fertilizer has become widespread (Amer Badawy Abduljader Al-Jubory *et al.,* 2023).

In this case, a very small amount of crushed arable land is placed in an aqueous medium for five to ten days to ferment, and the fermented liquid mass is used as a biological liquid fertilizer for dills. It has been confirmed that such liquid biological fertilizers have high biological efficiency due to the presence of a complex of microorganisms that accelerate various biological processes (Zhaoxiang *et al.,* 2020).

The most common way to assess the productivity of a crop is to measure its grain yield, oil storage properties in the grain, and the amount of fatty acids in the oil of this dill (Dimov *et al.,* 2020).

Therefore, in our further studies, additional studies were conducted to study the changes in grain formation properties of sorghum under the influence of biological fertilizers and the effect of biological fertilizers on the variability of sorghum grain composition.

These studies were conducted based on the results of the above studies, based on the selected amounts and standards of biohumus and zoohumus.

In the results of the study, some biochemical properties of Dille were determined in selected standards of biohumus.

Author Contributions

M. Z. Abdutolibov: Investigation, formal analysis, writing—original draft. N. A. Khujamshukurov: Validation, methodology, writing—reviewing. D. Kh. Kuchkarova:—Formal analysis, writing—review and editing. Alvina Farooqui: Investigation, writing—reviewing. Tripath Gyanendra: Resources, investigation writing—reviewing. Z. B. Xoliqov: Validation, formal analysis, writing—reviewing.

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

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