

REVIEW

of the official reviewer Halyna ZHATOVA,
for PhD thesis of

Xihuan Zhang

“Effects of long-term biogas slurry application on soil properties and crop yield in the North China Plain”,

submitted for a Doctor Philosophy Degree (PhD)

Field of study: 20 – Agricultural sciences and food

Specialty: 201 – Agronomy

Relevance of the dissertation topic. Ensuring the increase in wheat production is crucial to China's food security and the stable development of global food market supply and demand. Henan province is one of major agricultural province of China. Zhoukou is located in the southeast part of Henan Province, in the hinterland of Huanghuai Plain as the core area of grain production. The grain fields in this area generally adopt to the double cropping system, and the main wheat production is the cultivation mode of winter wheat and corn twice cropping a year.

Biogas engineering not only treats manure and produces clean energy, but also provides biogas slurry that can be used as organic fertilizer. Biogas slurry is rich in nutrients such as nitrogen, phosphorus and potassium and micronutrient elements such as calcium, copper, iron, zinc and manganese. However, the content of mineral nutrients in biogas slurry of different raw materials varies greatly.

In crop growing the soil quality is easily degraded, production costs are high, and the rate at which chemical fertilizer is utilized as nutrient source is rather low. With abundance of nutrients (including N, P, and K) as well as with rich organic matter, growth hormones, vitamins, and other essential components for plant growth, biogas slurry is considered as good fertilizer source for agricultural output. It benefits of high fertilizer efficiency and easy plant absorption. It also improves soil quality, lowers of production costs, and increases of crop yield.

In addition, for providing fertilizer for farmland, encouraging the use of biogas slurry in agricultural production it can also decrease of the environmental harm caused by large-scale aquaculture waste. It can also supply water-saving irrigation

in agriculture, which can effectively support the development of organic farming and animal husbandry as well as the promotion and use of efficient circular and low-carbon agricultural technology.

There are many studies on the application of biogas slurry in farmland in China and other countries, but there are significant regional variations in the climatic conditions, soil composition, physical, and chemical properties of the slurry as well as ways and methods of its application. If these factors are not taken into account, it could easily lead to the decline in the rate of fertilizer use, crop growth inhibition, decrease in yield quality and other unfavorable consequences. As a result, the use of biogas slurry in agricultural production should be acceptable and effective, considering of local conditions.

The aim of this study was to investigate the effects of various concentrations of biogas slurry on the physical and chemical properties of soil nutrients, enzyme activities and winter wheat yield.

Experiment was carried out with winter wheat grown in Zhoukou region on the lime concretion black soil to determine its impact on soil texture, wheat yield, and possibility to support sustainable agricultural development.

In order to improve soil health, growing technology, and supply of high winter wheat quality and yield, it is imperative to create scientific fertilization schemes, to maximize the use of biogas slurry in agrocenoses, to improve of agricultural production efficiency and to support the sustainable development of agriculture.

Connection with scientific programs, topics, plans. This work was supported by the science and technology key project of Henan Province (No 212102110388) and by the key scientific research project of Henan Provincial University (No 20B210004) (China). The research was also carried out in accordance with the thematic plans of research works of the department of agrotechnologies and soil science of the Sumy National Agrarian University and within the framework of the topics “Biologization of the farming system through a rational combination of methods of soil cultivation and sideration” (No 0115u0010055). In 2021 the project within this dissertation named “Impact of organic fertilizers from biogas plants on

microbiological, physical and chemical properties of soil and crop growth” was supported by mini-grant due to participating in the project of “Interuniversity cooperation as a tool for enhancement of quality of selected universities in Ukraine” financed within the Development Cooperation of the Czech Republic (Ministry of Foreign Affairs).

Scientific novelty of the obtained results. The aim of the study is to find out possibilities of biogas slurry in enhancing winter wheat yield and quality as well as determine its optimal capability. The improvements in the physical and chemical features of the soil, the activities of enzymes, the winter wheat grain and straw, and the overall quality and efficiency of the winter wheat were examined in relation to the effects of biogas slurry.

The benefit of the research result. It was confirmed the positive effects of biogas slurry on agricultural production such as increasing fertility, stress resistance, and crop production. The research results also determined the optimal concentration of biogas slurry used in Zhoukou lime concretion black soil. It will assist in reduction of environmental pollution caused by large-scale aquaculture waste, which in turn people help to realize the value of biogas slurry in terms of social benefits, economic benefits, and environmental protection.

For the first time the effects of application of biogas slurry on winter wheat growing on lime concretion black soil and as well as soil quality in Zhoukou region were studied and evaluated comprehensively. It was determined the difference of biogas slurry with various concentrations, and the best application concentration of biogas slurry (BS50) was determined.

It was find out the best application amount of biogas slurry for increasing the yield and quality of wheat, and provided a basis for the scientific application of biogas slurry.

The practical significance of the obtained results. The obtained results will contribute to the bioenergy development in China and Ukraine, ecological stabilization of the environment and solving the problems of soil degradation. The practical significance will lie in the implementation of the obtained research results

in agriculture, and more specifically, in the use of it in crop rotations with winter wheat, which occupy significant areas in both countries. The results of research can be implemented at enterprises that have the biogas plants and operate on waste from the livestock industry. According to the situation of Zhoukou area and environmental protection, BS50 treatment of biogas slurry and chemical fertilizer is recommended, which is conducive to improving lime concretion black soil, improving soil fertility and increasing winter wheat yield. The application of biogas slurry in agricultural production can significantly increase organic matter and provide plants with nutrients.

Based on research of Xihuan Zhang, the effect of biogas slurry application was obtained, the relationship between soil and winter wheat measurement indexes was clarified, the soil fertility was improved, the growth and development of winter wheat was promoted, the yield and quality of winter wheat was increased. At the same time, the use of chemical fertilizer, the cost of agricultural production and environmental pollution were reduced, and agriculture and animal husbandry were closely combined. It is beneficial to the sustainable development of agriculture. The research results have been approved by the Department of Education and the Department of Science and Technology of Henan Province.

An analysis of the plagiarism check report for the presence of textual borrowings (Unicheck by Turnitin) was carried out, which proved that dissertation work of Xihuan Zhang entitled «Effects of long-term biogas slurry application on soil properties and crop yield in the North China Plain is the result of independent research of the applicant and does not contain elements of plagiarism and borrowing in accordance with the resolution of the Cabinet of Ministers of Ukraine dated 12.01.2022 No. 44, paragraph 9. The used ideas, results and texts of other authors have a link to the corresponding source.

Number of scientific publications. The results of the thesis are presented in 11 papers: 2 articles in the scientific professional journal of Ukraine, category B; 1 article in a scientific journal, included in the database of Scopus, Web of Science, (Q1); 4 abstracts of reports at international scientific and practical conferences. The

materials of the papers and abstracts of conferences reflect the main provisions and conclusions of the PhD thesis.

Discussion clauses, comments and wishes regarding the content. Positively evaluating dissertation, its important scientific-theoretical and practical significance, novelty and relevance of research, it is appropriate to make the following comments and wishes.

1. In the work the technology of winter wheat growing was not presented in detail, namely the sowing rate, term of sowing and harvesting, using of pesticides.
2. The determination of the enzymatic activity of the soil was represented in the dissertation. But it would be expedient to determine the dynamics of species number of microorganisms in the arable and subsoil layers.
3. It is desirable to clarify what is the amount of waste produced by the biogas plant annually and how many hectares can be fertilized with biogas slurry from one station from which you took waste.
4. It would be expedient to determine the ratio of carbon to nitrogen, soil respiration, it is important in the context of global warming and anthropogenic stress on the soil environment.
5. The explanation of the determination of the height index of wheat plants is not quite well laid out. It would be appropriate to present a more detailed explanation in the form of figure and formula.

These remarks do not diminish the scientific value of the dissertation and some of them only reflect the reviewer's scientific position, which can also serve as a reason for discussion.

Correspondence of the dissertation to the specialty and the profile of the specialized academic council. The dissertation work of Xihuan Zhang entitled «Effects of long-term biogas slurry application on soil properties and crop yield in the North China Plain», which was submitted for defense to the specialized academic council for obtaining the degree of Doctor of Philosophy in the field of knowledge 20 – Agricultural sciences and food in the specialty 201 – Agronomy in terms of its relevance, scientific and theoretical level, main results of validity, main provisions

and results published in professional publications, and novelty of the setting and practical significance meets the requirements of the order of the Ministry of Education and Science of Ukraine No.40 dated January 12, 2017 «On approval of requirements for registration dissertation» and the Decree of the Cabinet of Ministers of Ukraine dated January 12, 2022 No.44 “On approval of the Procedure for awarding the degree of Doctor of Philosophy and cancellation of the decision of the one-time specialized academic council of the higher educational institution, scientific institution on awarding the degree of «Doctor of Philosophy» with amendments made according to the Resolution of the Cabinet of Ministers No. 341 dated 03.21.2022. The content of the dissertation corresponds to the passport of the specialty. Xihuan Zhang deserves to be awarded the scientific degree of Doctor of Philosophy in specialty of 201 – Agronomy.

Official Reviewer:

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