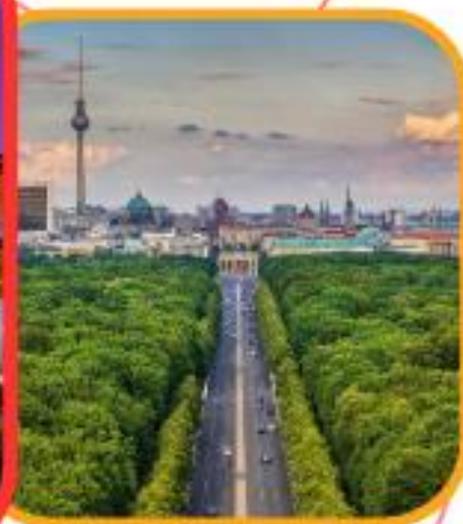




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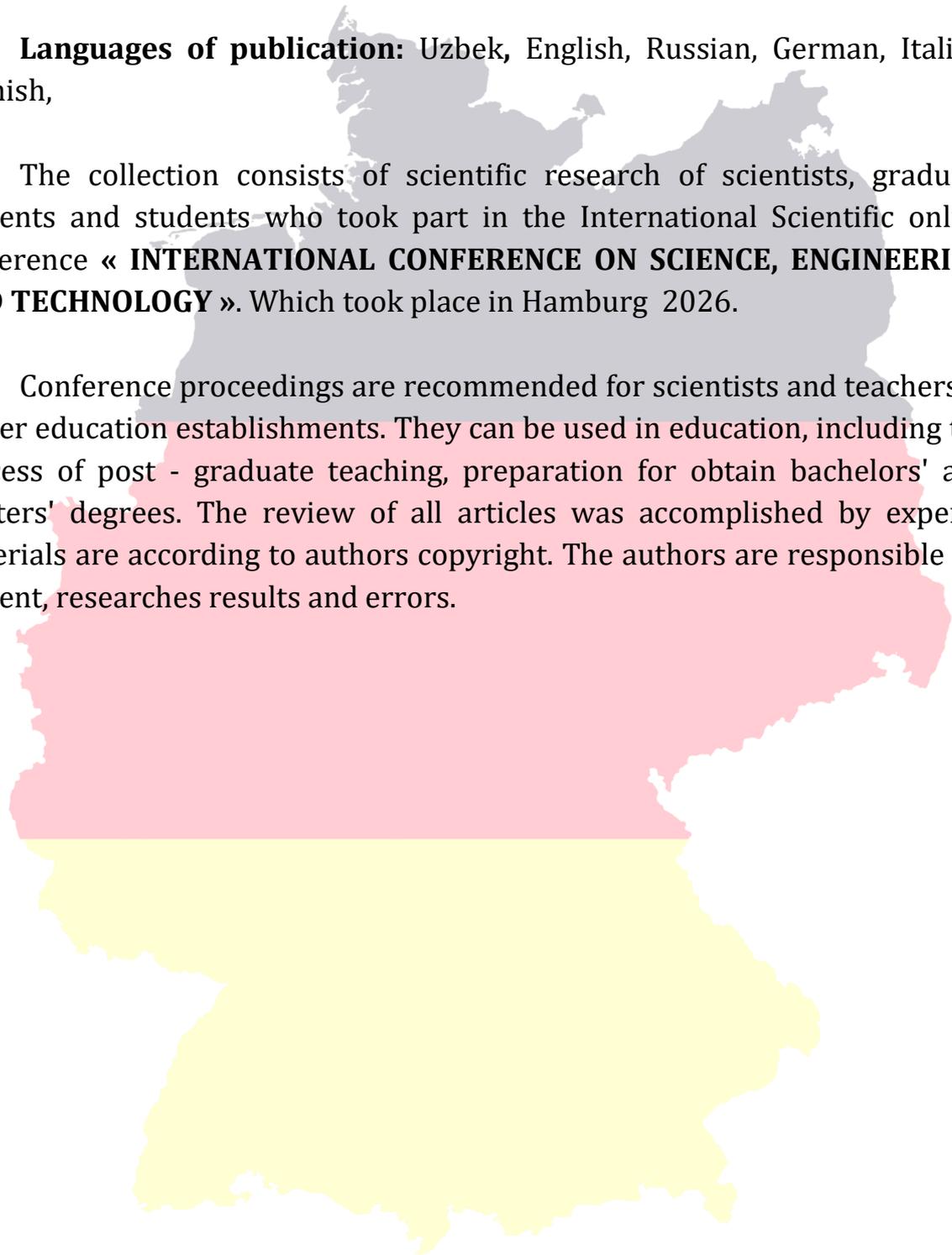


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DEVELOPMENT OF LOCALLY-SOURCED PHOSPHORUS-BASED MINERAL FERTILIZERS ENRICHED WITH PLANT GROWTH STIMULANTS: TECHNOLOGY AND APPLICATION

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Abstract. Phosphorus is a vital nutrient that regulates multiple physiological processes in plants, including photosynthesis, energy transfer, nucleic acid synthesis, and root development. Conventional phosphorus fertilizers rely heavily on imported raw materials, which increases production costs and creates economic vulnerability in developing agricultural regions. This study explores the development of locally-sourced phosphorus-based fertilizers enriched with plant growth stimulants, such as humic acids and essential microelements (Zn, Fe, B), to improve nutrient uptake efficiency and crop productivity. The raw materials utilized include local phosphorite ores, apatite concentrates, and industrial by-products, particularly phosphogypsum. Activation techniques employed are chemical, mechanochemical, and biological, each aimed at improving phosphorus solubility and bioavailability. Granulated formulations were produced through controlled granulation, drying, and cooling processes, resulting in slow-release fertilizers with optimized physical properties. Greenhouse trials demonstrated enhanced phosphorus uptake, improved root architecture, increased biomass, and higher chlorophyll content. The proposed approach combines cost-effectiveness, environmental sustainability, and high agronomic efficiency, offering a viable strategy for modern, resource-efficient agriculture.

Keywords: phosphorus fertilizers, local raw materials, plant growth stimulants, phosphorite activation, mechanochemical activation, slow-release fertilizers, sustainable agriculture

1. Introduction. Phosphorus (P) is a non-renewable, essential macronutrient for plant development. It plays a pivotal role in energy metabolism (ATP/ADP cycles), photosynthetic efficiency, and root and shoot development, impacting both yield and crop quality. Despite its importance, phosphorus often exists in soils in sparingly soluble forms, particularly in calcareous and alkaline soils, limiting plant uptake. Phosphorus deficiency is a global issue affecting productivity, especially in arid and semi-arid regions.

Uzbekistan and other Central Asian countries have substantial phosphorite reserves, but natural phosphorite has low chemical reactivity, necessitating treatment before use as fertilizer. Traditional fertilizers, such as superphosphate, rely on imported high-grade phosphates, increasing production costs and creating economic dependency. The development of fertilizers based on locally available phosphorites and industrial by-products represents both an economic and



environmental opportunity, contributing to the national agricultural self-sufficiency.

Moreover, recent research emphasizes the importance of plant growth stimulants in enhancing nutrient efficiency. Humic acids, fulvic acids, and selected microelements (Zn, Fe, B) positively influence root proliferation, nutrient mobilization, and microbial activity in the rhizosphere. Incorporating these compounds into phosphorus fertilizers not only improves phosphorus uptake but also enhances overall plant growth, resilience to stress, and productivity.

This study investigates the integration of local raw materials, advanced activation methods, and biologically active additives to develop efficient, slow-release phosphorus fertilizers, providing both economic benefits and environmental protection.

2. Background and Literature Review. The efficiency of phosphorus fertilizers is limited by low solubility and strong fixation in the soil. Conventional fertilizers release phosphorus rapidly, which may leach or bind to soil minerals, resulting in low nutrient use efficiency. Various activation strategies have been studied to overcome this limitation:

1. **Chemical Activation:** Phosphorite reacts with acids (H_2SO_4 , H_3PO_4) to produce water-soluble monocalcium phosphate, increasing immediate phosphorus availability. The reaction also generates phosphogypsum, which can serve as a secondary source of sulfur.

2. **Mechanochemical Activation:** High-energy milling reduces particle size, increases surface area, and induces lattice defects in apatite, enhancing slow phosphorus release and improving interaction with soil acids.

3. **Biological Activation:** Phosphate-solubilizing microorganisms (PSMs), such as *Bacillus*, *Pseudomonas*, and *Azotobacter* species, release phosphorus from insoluble sources through organic acid secretion and enzymatic activity, ensuring long-term nutrient availability.

Additionally, incorporating humic substances stimulates root growth, microbial activity, and nutrient mobility, while microelements such as Zn, Fe, and B play critical roles in enzyme activation, chlorophyll synthesis, and reproductive development. Combining activation methods with biologically active additives improves overall fertilizer performance and crop response, providing a sustainable approach to modern agriculture.

3. Materials and Methods

3.1 Raw Materials. The fertilizers were formulated from locally sourced minerals and industrial by-products, as detailed below:

- Phosphorite ores: Mainly fluorapatite ($Ca_5(PO_4)_3F$), with 12–20% P_2O_5 . Contains impurities such as $CaCO_3$, Fe_2O_3 , and SiO_2 .

- Apatite concentrates: High-reactivity source of P_2O_5 (28–40%), also contributing calcium.



- Phosphogypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$): By-product of phosphoric acid production, containing 0.5–1.5% residual P_2O_5 and sulfur.

Additives: Humic substances from leonardite or peat and microelements (Zn, Fe, B) in soluble or chelated form.

All raw materials were analyzed for chemical composition (P_2O_5 , Ca, S, trace elements), particle size distribution, and mineralogical composition using X-ray diffraction (XRD).

3.2 Activation Methods. Chemical Activation: Treatment with sulfuric acid converts insoluble phosphates to water-soluble monocalcium phosphate.

Mechanochemical Activation: High-energy milling produces fine particles with lattice defects, promoting gradual phosphorus release.

Biological Activation: Phosphate-solubilizing microorganisms increase phosphorus bioavailability via secretion of organic acids and phosphatase activity.

3.3 Fertilizer Preparation. Activated phosphorite was mixed with humic acids, microelements, and optional N/K sources, then homogenized. Granules (2–5 mm) were formed through drum granulation, dried at 80–120°C, cooled, and screened for uniform size.

3.4 Analytical Methods.

- Phosphorus content: Total and plant-available P_2O_5 via wet chemical and spectrophotometric methods.

- Structural analysis: XRD for mineral phases, IR spectroscopy for phosphate and organic functional groups.

- Plant trials: Greenhouse experiments measured root/shoot biomass, chlorophyll content, and overall plant growth.

4. Results and Discussion. All activation techniques significantly improved phosphorus solubility:

- Chemical activation: Maximum immediate phosphorus availability.

- Mechanochemical activation: Moderate but sustained release.

- Biological activation: Continuous long-term availability.

Addition of humic substances and microelements enhanced root proliferation, nutrient uptake, and shoot biomass. Greenhouse trials demonstrated 15–30% increase in biomass and chlorophyll content relative to untreated controls. Granulated fertilizers exhibited uniform size, high mechanical strength, and slow-release properties, reducing leaching and improving nutrient use efficiency.

5. Technological Process. The fertilizer production process includes:

1. Crushing and grinding of raw materials (<0.1 mm)
2. Activation (chemical, mechanochemical, or biological)
3. Mixing with humic substances and microelements
4. Granulation (2–5 mm)
5. Drying (80–120°C)
6. Cooling and packaging



This technological scheme is compatible with existing fertilizer production facilities, requires low capital investment, and allows for large-scale production.

6. Economic and Environmental Assessment

- Utilizing local phosphorites reduces dependence on imports and lowers production costs.

- Phosphogypsum use recycles industrial waste and provides sulfur for crops.

- Slow-release fertilizers reduce nutrient losses, prevent groundwater contamination, and decrease eutrophication risks.

- Humic substances improve soil structure, microbial activity, and long-term fertility, supporting sustainable agriculture.

7. Conclusion. This study confirms the feasibility of producing locally sourced phosphorus fertilizers enriched with plant growth stimulants. The fertilizers provide:

- High phosphorus bioavailability

- Enhanced plant growth due to humic substances and microelements

- Slow nutrient release, reducing environmental impact

- Cost-effective, industrial-scale production

The proposed technology combines agronomic efficiency, environmental sustainability, and economic viability, offering a practical solution to improve crop productivity and soil fertility in Central Asia.

References

1. Chien, S. H., Prochnow, L. I., & Tu, S. (2011). Agronomic and environmental aspects of phosphate fertilizers. *Advances in Agronomy*, 109, 165–216.

2. Vance, C. P., Uhde-Stone, C., & Allan, D. L. (2003). Phosphorus acquisition and use: Critical adaptations by plants for securing a nonrenewable resource. *New Phytologist*, 157(3), 423–447.

3. Cordell, D., Drangert, J. O., & White, S. (2009). The story of phosphorus: Global food security and food for thought. *Global Environmental Change*, 19(2), 292–305.

4. Zhang, F., Shen, J., Zhang, J., et al. (2010). Rational use of fertilizers in agriculture. *Journal of Experimental Botany*, 61(2), 1–12.

5. Richardson, A. E., Simpson, R. J. (2011). Soil microorganisms mediating phosphorus availability. *Plant Physiology*, 156(3), 989–996.