

Obtaining water-saving complex fertilizers based on local raw materials

Talat Abduhakimov*, and Doniyor Sherkuziev

Department of Material science and technology of new materials, Faculty of Chemistry Technology, Namangan Institute of Engineering and Technology, Kasansay str. 7, Namangan, 160115, Uzbekistan

Abstract. The article presents the results of research on the production of moisture-retaining complex fertilizers that save water resources and mineral components based on local raw materials. The synthesis process of FarPAN raw material with formalin, inorganic and organic acids and monoammonium phosphate (MAF) as a fertilizer has been studied. As a result of the study, FarPAN and the hydrogel sample obtained after neutralization with sulfuric acid were analyzed in the IR spectrum. According to the results of the analysis, a new type of 20% MAF-based moisture-retaining fertilizer was chosen as the most optimal option, and physico-chemical analyzes of the sample (elemental analysis (SEM_EDX)) were studied. It was determined that the resulting moisture-retaining fertilizers can be used in agriculture as a means of providing moisture and nutrient components in water-scarce areas.

1 Introduction

The Republic of Uzbekistan currently has 25,736,000 square meters of designated agricultural land, including 4.3 million square meters consisting of irrigated land. 97% of all agricultural products are obtained from irrigated lands in the republic. Uzbekistan ranks 5th in cotton production in the world. In recent years, she has achieved independence with more than 6.1 million tons of grain products mainly wheat cultivation crops. As a country with a rapidly growing population, Uzbekistan had 14 million people in 1975. 79,000 people lived there, and now there are 32.4 million people living. Due to water scarcity, opportunities to increase irrigated arable land are limited as a result of water scarcity. The population cannot be high even when calculated per capita. In 1970, there was 0.22 meters of irrigated land per person, but in current indicators it has decreased to 0.14 meters [1]. In such conditions, the growing state of the country, agricultural production can be compensated only by accelerating, increasing the productivity of plants and its chemicalization.

Today, in the country, special attention is paid to the introduction of water-saving technologies in the development of agriculture. In this regard, the Tashkent Scientific Research Institute of Chemical Technology and a number of higher educational institutions

* Corresponding author: talatbek1995@mail.ru

have achieved a number of results on the development of highly elastic hydrogels for several years. This kind of achievements has been on the synthesis of new macromolecular hydrogels based on HYPAN and CMC (Carboxymethylcellulose) with new sewing agents, looked through synthesized products and determined their structure by various physico-chemical and physico-mechanical methods, shows the making and developing of industrial production of import-substituting products from local raw materials and industrial wastes to saturate the domestic market [2, 3].

Polymer hydrogels were obtained by polymerizing hydrophilic acrylic acid molecules with carboxymethylcellulose (CMC). In this work, new cross-linking agents were synthesized based on aminoalkyl acrylates derived from acrylic acid, N-N diethylamine acrylates and dichlorohydrin glycerol [4]. Hydrogels also have a degree of flexibility very similar to that of natural tissues due to their significant water content. The main material used was sodium salt of carboxymethylcellulose, which is a biomaterial for the preparation of hydrogel with optimal cross-linking [5].

Based on the analysis of the above literature, the production of export-oriented complex gel-composite fertilizers, which replaces imports in saving mineral fertilizers and water resources, is one of the urgent issues. The most important task is to eliminate the existing shortcomings and problems, to develop agriculture based on the changing climate conditions around the world. Including in this scientific work, research was carried out on obtaining complex-acting fertilizers with moisture retention properties based on local raw materials and their physico-chemical analysis.

2 Materials and methods

The FarPAN substance produced in Ferganazot in the territory of our Republic was used as a raw material in this research. FarPAN creates a strong alkaline environment (pH=14) due to the high content of ammonia. On the basis of FarPAN, studies were conducted on obtaining complex-acting fertilizer hydrogels, and physico-chemical analyzes of raw materials were also performed [6-10]. IK-spectroscopic studies of FarPAN in Figure 1 were determined on a Perkin-Elmer FT-IR Spectrum 3 spectrophotometer at a frequency of $4000 \pm 400 \text{ cm}^{-1}$, and the obtained results were checked based on special references [11].

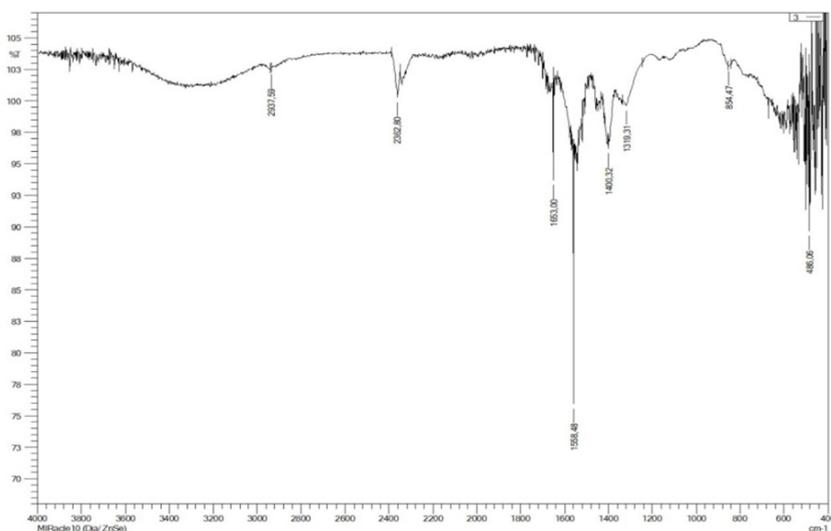


Fig. 1. IK spectrum image of a FarPAN sample.

As can be seen from the IR spectrum of the FarPAN sample in Figure 1, absorption lines in the region of 2937.59-2362.80 cm⁻¹ are explained by the presence of -(OH) groups. Absorption lines in the region of 1653.00 cm⁻¹ and 1558.48 cm⁻¹ were found to be -(C=O) -(NH₂) valence vibrational frequency groups. It was also determined that there is a -(CO) group in the area of 1400.32 cm⁻¹, -(CO₂) group in the area of 1319.31 cm⁻¹, and -(NH) groups in the area of 854.47 cm⁻¹.

During the research, a hydrogel was obtained in the presence of FarPAN, formalin, organic and sulfuric (45%) acids. The IK-spectrum of this hydrogel is represented in Figure 2.

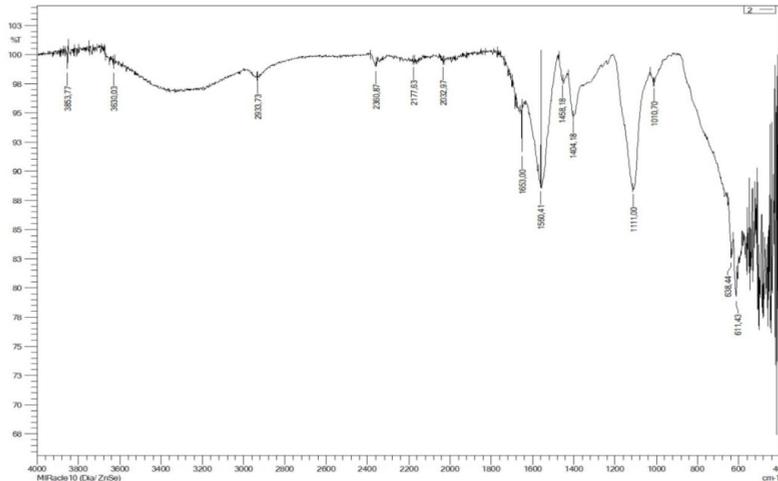


Fig. 2. IK spectrum image of the hydrogel sample obtained based on FarPAN.

In the IK-spectrum absorption lines of the FarPAN-based hydrogel sample shown in Figure 2, the following vibrational frequencies were determined cm⁻¹: -(OH) groups between 3853.77 and 3630.03, and -(OH) groups in the absorption lines from 2933.73 to 2032.97 (SONH₂), -(NH) were found to belong to the groups. Absorption lines in the area of 1653.00 and 1560.41 were found to be -(C=O) -(NH₂) amide valence vibration frequency groups. These groups are explained by the wavelength difference of the frequencies compared to the absorption lines presented in Figure 1. It was found that the absorption bands in the 1458.32 and 1404.18 areas are -(CO) group, in the 1111.00 and 1010.70 areas -(N-O) group, and in the 638.44 and 611.43 areas -(SO₄-2) groups are found.

3 Results and discussion

Based on the results of the above analysis, research was conducted on the production of moisture-retaining complex fertilizer on the basis of FarPAN, which is considered the main raw material, and hydrogel samples obtained on the basis of various preparations. In the results of the research, the change in the consumption standards of the main raw materials was carried out with the change in the percentage concentration of inorganic acids. In the process of obtaining moisture-retaining fertilizers, various fertilizers ammaphos, NPK (18.18.18), urea, ammonium sulfate, AFU and various other nutrient-preserving micro- and macro-elements were introduced. Experiments were also conducted with changes in the norms of consumption of these fertilizers.

In the course of scientific research, in this article, the most suitable option of the moisture-retaining complex fertilizer was selected. In the research work, the main raw

materials FarPAN, formalin, organic and nitric (30%) acids were obtained. Analysis of moisture-retaining fertilizer with monoammonium phosphate (MAF) as a fertilizer was carried out. Figure 3 shows the consumption of raw materials.

As shown in Figure 3, 71% of the gelled mass was FarPAN. We can see that formalin is 3%, organic acid is 2% and monoammonium phosphate as fertilizer is 20%. The consumption percentage of nitric acid was 4%, in our previous studies, the norm of consumption of nitric acid was 4%, which was chosen as the most optimal option, at the same time, a 30% solution of acid with a change in concentration of 30-60% was selected during the research [12].

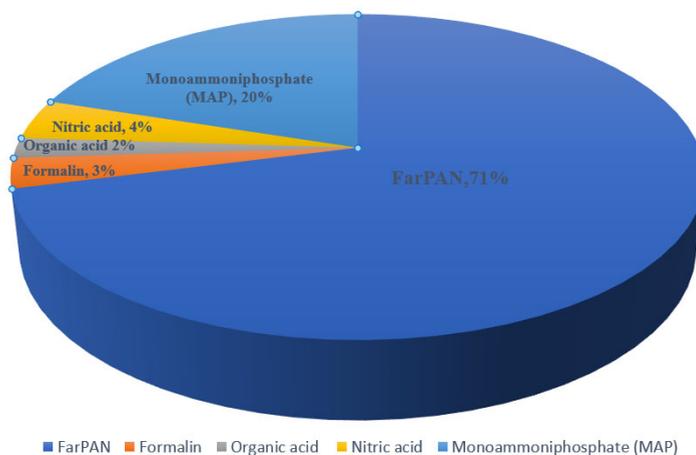


Fig. 3. Consumption criteria of raw materials for obtaining moisture-retaining fertilizer.

The raw materials were sequentially mixed for 3 hours using a laboratory-equipped mixer (model: OS20-S), digital electric heater (model: HP550-S), and the process was carried out at a temperature range of 70-75 oC, pH readings (PHscan30 Pocket pH Tester) was controlled. The obtained samples were subjected to physical and chemical analysis. The results of the analysis are presented in Figures 4-5 and Table 1.

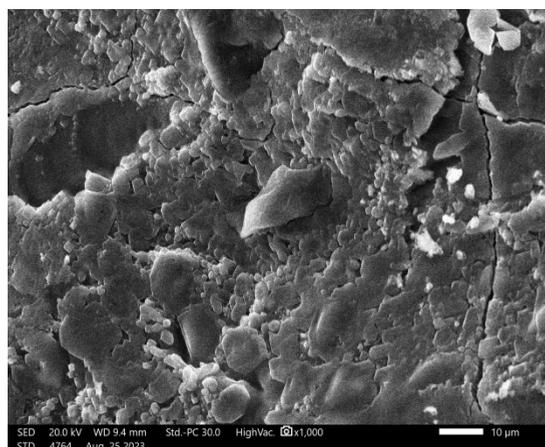


Fig. 4. Scanning electron microscope (SEM) view of the internal structure of monoammonium phosphate (MAF) preservative gel-based fertilizer.

Element analysis scanning electron microscope (SEM-EDX)-JSM-IT200 (JEOL, Japan) SEM-EDA-Electron beams (in electron microscopes) or X-rays (in X-ray fluorescence analyzers) are used to excite the atoms of the studied sample, determined by X-ray radiation characteristic of each chemical element.

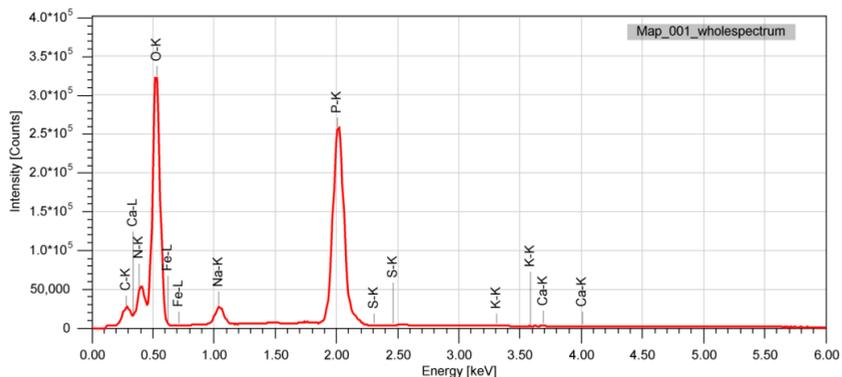


Fig. 5. Scanning electron microscope (SEM) spectra of gel-based fertilizer containing monoammonium phosphate (MAF).

Analysis in Figure 5 and Table 1 shows that the highest element was observed to be O-52.59 mass % followed by P-18.11 mass %. Micro- and macro-fertilizers for plants were determined in the calculated Ca-0.04 mass %, K-0.11 mass %, Fe-0.03 mass %, S-0.03 mass %.

Table 1. Composition of fertilizer containing monoammonium phosphate preservative gel.

Nº	Element	Mass %	Atom %
1	C	14.760±0.02	20.25±0.03
2	N	12.08±0.02	14.22±0.03
3	O	52.59±0.04	54.19±0.04
4	Na	2.25±0.01	1.62±0.01
5	P	18.11±0.02	9.64±0.01
6	S	0.03±0.00	0.01±0.00
7	K	0.11±0.00	0.05±0.00
8	Ca	0.04±0.00	0.02±0.00
9	Fe	0.03±0.00	0.01±0.00
Total		100,00	100,00

4 Conclusion

The results of the research showed that, based on the results of the elemental analysis of the MAF-preserving complex fertilizers synthesized on the basis of local raw materials, today in agriculture, in the cultivation of products in phosphorus and water-deficient lands, in this

place, cities and villages, allows for extensive use in the development of horticulture, as well as in the conversion of green space.

References

1. B.M. Beglov, Chemical industry today **10** (2004)
2. D.Sh. Sherkuziev, Sh.Sh. Davlatovich, M.O. Yusupov, O. Askarova, Eur. Sci. Rev., E **1(11-12)** (2018)
3. R.Z. Omirova, A.A. Bolysbek, S.D. Shirinov, A.T. Dzhililov, Ras. Jour. of Chem. **12(4)** (2019)
4. L.R. Djuraeva, U.A. Barakaev, *Opredeleniya nabukhaniya polimernye hydrogelya*, International Conference on Research in Humanities, Applied Sciences and Education, 93-94 (2022)
5. B.A. Kholnazarov, Kh.Kh. Turaev, Yu.E. Nazarov, Synthesis of hydrogels based on biomaterials starch and sodium carboxymethylcellulose, Universum: chemistry and biology: electron. scientific magazine **10(76)** (2020)
6. T.T. Abdusakimov, D.Sh. Sherquziyev, X. Aripov, Using local raw materials for clinker production, Universum: technical sciences: electron. scientific magazine **10(79)** (2020)
7. T.T. Abdusakimov, D.Sh. Sherquziyev, X. Aripov, IOP Conf Ser: Earth and Environmental Science **1142(1)**, 012055 (2023)
8. T.T. Abdusakimov, D.Sh. Sherquziyev, S. Xolboyeva, Inter. Conf. on Sci. Res. in Nat. and Soc. Sci. **2(8)** (2023)
9. T.T. Abdusakimov, D.Sh. Sherquziyev, Sci. and tech. jour. of mech. engi. (2022)
10. D.Sh. Sherquziyev, X. Aripov, M.A. Maxmudova T.T. Abdusakimov, Pers. of Wor. Sci. and Edu. **79**, (2020)
11. N.A. Redkin, *Fourier transform infrared spectrometry and mass spectrometry in the identification of organic compounds* (Samara, Samara University Publishing House, 2019)
12. T.T. Abdusakimov, D.Sh. Sherquziyev, Nam Ins of E and T. Sci. and Tech. Jour. (2023)