WEB OF SCIENTIST: INTERNATIONAL SCIENTIFIC RESEARCH JOURNAL
ISSN: 2776-0979, Volume 5, Issue 2, February, 2024

PRODUCTION OF LIQUID FERTILIZERS CONTAINING PHYSIOLOGICALLY ACTIVE SUBSTANCE AND TRACE ELEMENTS

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Abstract

At present, much attention is paid to the production of complex liquid fertilizers containing N, Ca, P_2O_5, K_2O, as well as plant protection products, physiologically active substances, insecticides, etc. Of great interest is the study of the combined use of liquid fertilizers with physiologically active substances that contribute to the acceleration of growth, development of plants and obtaining effective yields.

In addition, the use of trace elements is an inseparable part of measures to increase the yield of agricultural crops, since the use of only mineral and organo-mineral fertilizers is not enough for the normal development of plants.

The role of trace elements in plant nutrition is multifaceted. Micronutrients increase the activity of many enzymes and enzyme systems in the plant organism and improve the use of macrofertilizers and other nutrients from the soil by plants [1].

Therefore, this article is devoted to scientific research on the production of liquid fertilizers containing, in addition to N, Ca, Mg, K_2O, also a physiologically active substance and trace elements.

Earlier, we identified the optimal conditions for obtaining liquid fertilizer by nitric acid decomposition of dolomite with the obtaining, after separation of the insoluble residue, a solution of calcium and magnesium nitrates with subsequent enrichment of the latter with ammonium and potassium nitrate [2].

In order to obtain a liquid fertilizer containing the physiologically active substance nitric acid monoethanolammonium, the dependence of changes in the physical and chemical properties of solutions on the composition of components in the system $\{68.0[41.53\%\sum Ca(NO_3)_2+Mg(NO_3)_2+58.47\%H_2O]+20\%NH_4NO_3+8.0\%KNO_3+3.25\%_{NH_2C_2H_4OH}\}$-$HNO_3\cdot NH_2C_2H_4OH$ by measuring the crystallization temperature, density, viscosity, and pH of the medium was studied [3,4,5]. On the basis of the data obtained, a diagram of the "composition-properties" of the system was created (Fig. 1).

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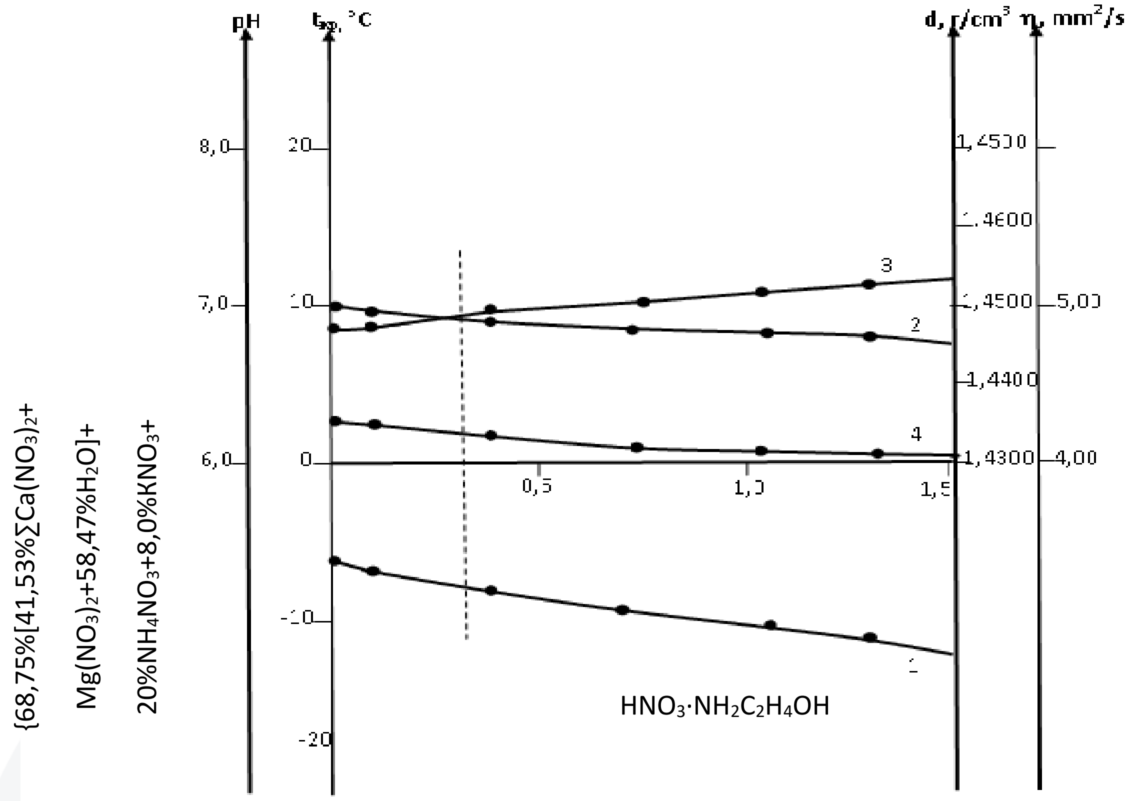

Fig.1. Dependence of changes in crystallization temperature (1), pH (2), density (3) and viscosity (4) of solutions on the composition in the system {68,75[41.53%∑Ca$(NO_3)_{2}$+M (NO3)$_{2}$+58,47%H2O]+ 20%NH4NO3+8,0%KNO3+3,25%NH2C2H4OH}-HNO3•NH2C2H4OH

It is known from the literature that the optimal dose of monoethanolammonium nitrate, which contributes to the acceleration of plant growth and development and accelerates the ripening process of agricultural crops, is 0.25÷0.3% [6].

Based on the results shown in Figure 1, it follows that when 0.25÷0.3% monoethanolammonium nitrate is dissolved in a solution of the composition {68.75[41.53%∑Ca(NO3)2+Mg(NO3)2+58.47%H2O]+20%NH4NO3+ 8.0%KN3+3.25%NH2C2H4OH}, a solution of liquid fertilizer with a temperature crystallization of -7.0÷-8.0°C, a density of 1.4479÷1.4490 g/cm3, a viscosity of 4.18÷4.24 mm2/s and a pH of 6.94÷6.98 is formed.

In order to introduce trace elements such as Cu, Co and Ni into the composition of the resulting liquid fertilizer, the dependence of changes in the crystallization temperature, density, viscosity and pH of the solution medium on the composition of components in the following systems was studied:

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I.{68,45%[41,53%∑$Ca(NO_3)_2$+$Mg(NO3)_2$+58.47%H2O]+20%NH4NO3+ 8.0%KNO3+3,25%NH2C2H4OH+0.3%HNO3•NH2C2H4OH}-$Cu(NO3)_2$•3H2O;
II. {68,45%[41,53%∑$Ca(NO_3)_2$+$Mg(NO3)_2$+58,47%H2O]+20%NH4NO3+ 8.0%KN3+3.25%NH2C2H4OH+0.3%HNO3•IEA}-$Co(NO3)_2$•6H2O;
III. {68,45%[41,53%∑$Ca(NO_3)_2$+$Mg(NO3)_2$+58,47%H2O]+20%NH4NO3+ 8.0%KN3+3.25%NH2C2H4OH+0.3%HNO3•MEA}-Ni(NO3)2•6H2O and their composition-properties diagrams were constructed (Fig. 2,3,4).

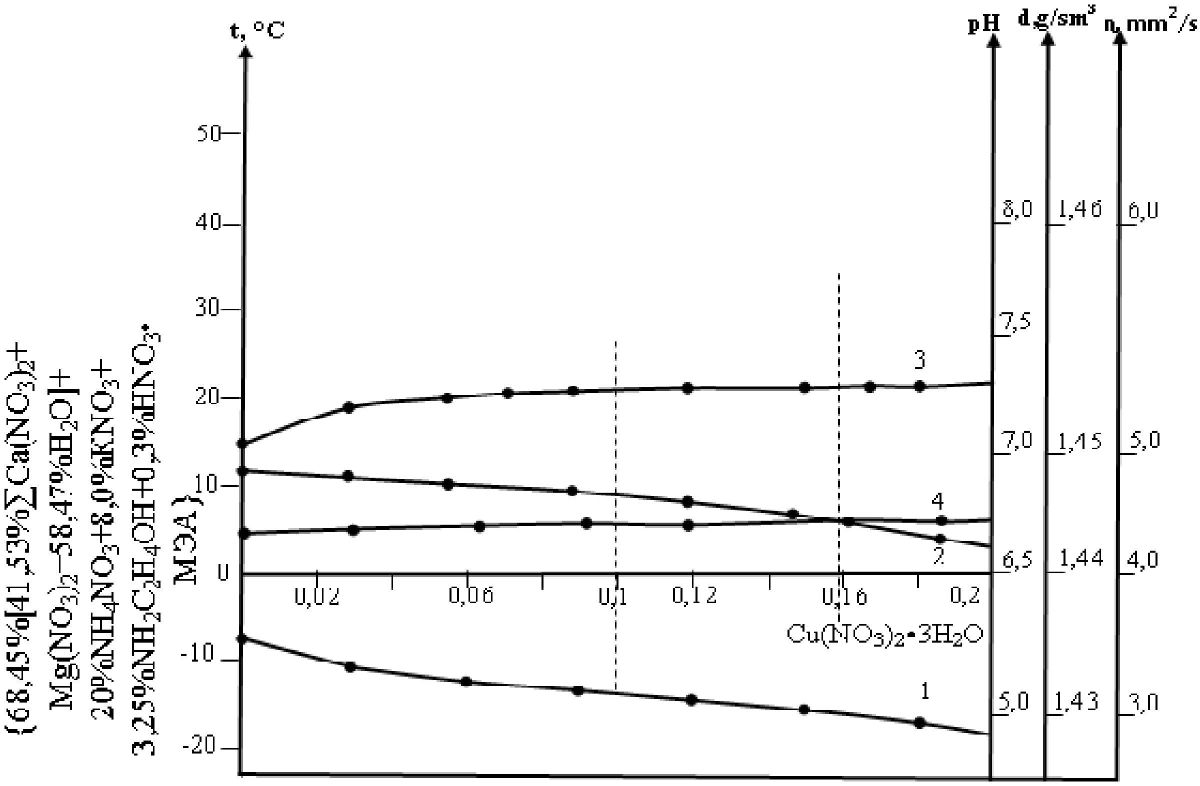
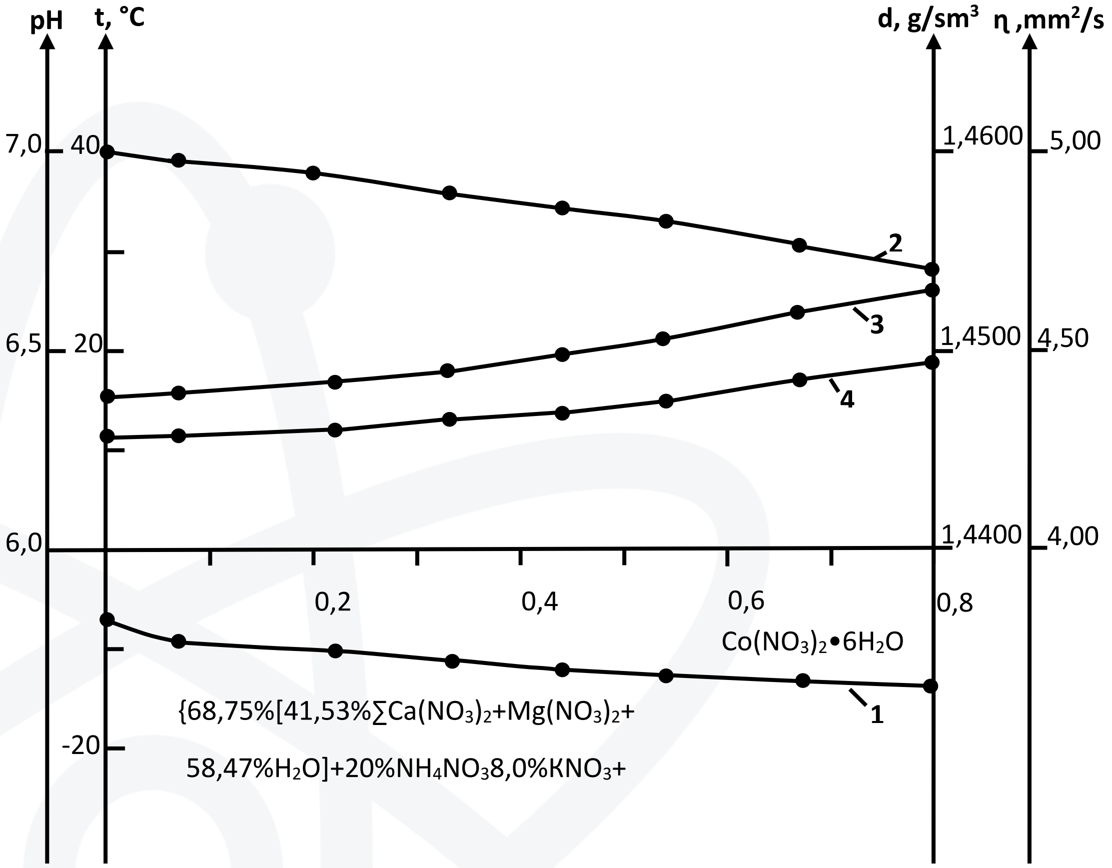


Fig.2.Dependence of changes in crystallization temperature (1), pH (2), density (3) and viscosity (4) of solutions on the composition in the system {68.45%[41.53%∑Ca(NO3)2+Mg(NO3)2+58.47%H2O]+20%NH4NO3+ 8.0%KN3+3.25%NH2C2H4OH+0.3%HNO3•MEA}-Cu(NO3)2•3H2O

Analysis of the "composition-temperature crystallization" and "composition-pH" diagrams (Fig. 2, curves 1.2) shows that as copper nitrate is added to the liquid fertilizer solution, the crystallization temperature and pH values of the newly formed solutions gradually decrease from -7.9°C to -18.0°C and pH from 6.94 to 6.68, respectively. The density and viscosity values of newly formed solutions gradually increase as copper nitrate is added (Fig. 2, curves 3.4) d from 1.4484 to 1.4522 g/cm3 and η 4.20 to 4.30 mm2/s, respectively.

On these curves of the diagram (Fig. 2) no fractures are observed, i.e. within the studied concentration limits of this system, there is no change in the crystallizing solid phases, and the components of the system retain their individuality, and therefore their physiological activity.

Analysis of the composition-properties diagram of System II (Fig. 3, curves 1-4) also shows that as cobalt nitrate is added to the liquid fertilizer solution, the crystallization temperature and pH values of the newly formed solutions gradually decrease from -7.0°C to -14.0°C and pH from 7.0 to 6.7, respectively. And the values of density and viscosity of newly formed solutions gradually increase with an increase in the concentration of cobalt nitrate.

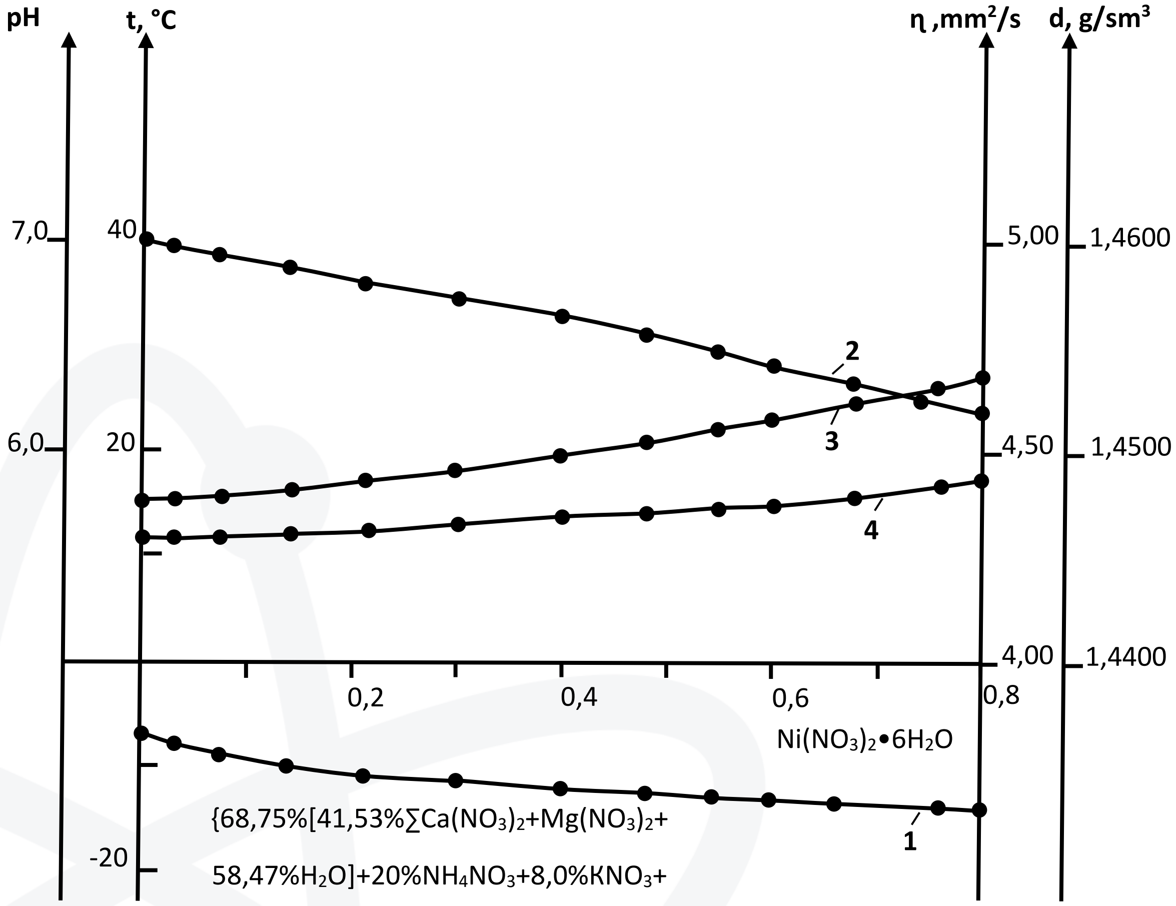


Rice. 3. Dependence of changes in crystallization temperature (1), pH (2), density (3) and viscosity (4) of solutions on the composition in the system {68.45%[41.53%∑Ca(NO3)2+Mg(NO3)2+58.47%H2O]+20%NH4NO3+8.0%KNO 3+3.25%NH2C2H4OH+0.3%HNO3•MEA}-Co(NO3)2•6H2O

ISSN: 2776-0979, Volume 5, Issue 2, February, 2024

There are also no fractures in the curves of the diagram of this system, i.e. within the studied concentration limits of this system, there is no change in the crystallizing solid phases, and the components of the system retain their individuality, and therefore their physiological activity.

Analysis of the composition-properties diagram of System III (Fig. 4, curves 1-4) also shows that as nickel nitrate is added to the liquid fertilizer solution, the same regularity is observed as in the previous systems I, II.



Rice. 4. Dependence of changes in crystallization temperature (1), pH (2), density (3) and viscosity (4) of solutions on the composition in the system {68.45%[41.53%$\sum Ca(NO_3)_2+Mg(NO_3)_2+58.47\%H_2O$]+ 20%$NH_4NO_3$+8,0%$KNO_3$+3,25%$NH_2C_2H_4OH$+0,3%$HNO_3$•МЭА}- ni$(NO_3)_2\cdot 6H_2O$

There are also no fractures in the curves of the diagram of this system III, i.e. within the studied concentration limits of this system, there is no change in the crystallizing solid phases, and the components of the system retain their individuality, and therefore their physiological activity.

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Based on the results of the study of the "composition-properties" of the above systems and preliminary agrochemical tests of various compositions, it follows that in order to obtain a liquid fertilizer of complex action containing the trace element Cu (or Co) (or Ni), it is necessary to dissolve copper nitrate (or cobalt nitrate) (or nickel nitrate) in the initial solution at a mass ratio of 1.0:0.001÷0.002. The resulting fertilizer solutions have the following physical and chemical properties:

1) The solution is blue in color, the crystallization temperature is -14.0÷-18.0°C, the density is 1.4516÷1.4522 g/cm3, the viscosity is 4.25÷4.30 mm2/s, pH=6.82÷6.62 and contains: mass. % Ntotal = 13.4; MgO=3,38; CaO=5,7; $K_{2O-3.6}$; FAW-0.25÷0.3; Cu-0,02-0,026.

2) The solution is reddish in color, the crystallization temperature is -9.0÷-10.0°C, the density is 1.4480÷1.4484 g/cm3, the viscosity is 4.29÷4.30 mm2/s, pH=6.97÷6.95 and contains: mass. % Ntotal = 13.4; MgO=3,38; CaO=5,7; $K_{2O-3.6}$; FAW-0.25÷0.3; Co-0.01÷0.02.

3) Green solution, crystallization temperature -10.0÷-11.0°C, density 1.4486÷1.4491 g/cm3, viscosity 4.33÷4.34 mm2/s, pH=6.80÷6.72 and contains: mass. % Ntotal = 13.4; MgO=3,38; CaO=5,7; $K_{2O-3.6}$; FAW-0.25÷0.3; Ni-0,01÷0,02.

These solutions can be recommended as liquid fertilizers of complex action, containing simultaneously such nutrients as N, Ca, Mg, K2O, FAV and Cu, (or Co), (or Ni).

Findings

Thus, by studying the dependence of changes in the physical and chemical properties of solutions on the content of components in the above systems, the optimal technological parameters for obtaining liquid fertilizers of complex action containing simultaneously such nutrients as N, Ca, Mg, K2O, FAV and Cu, (or Co), (or Ni) were established.

Preliminary agrochemical tests of the obtained fertilizers have shown their positive effect on the growth, development and acceleration of the ripening process of agricultural crops.

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ISSN: 2776-0979, Volume 5, Issue 2, February, 2024
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