Study of dry humic agrochemicals

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Abstract. The article presents the results of work on the determination of the physicochemical properties and biological activity of dry humic-containing agrochemicals produced on an industrial scale, sold in retail chains for personal household plots. To assess the effectiveness of their use, samples of dry agrochemicals containing humic substances and intended for pre-sowing, foliar and root treatment of plants were selected. The physicochemical properties of the samples were studied, such as the yield of free humic acids, the ash content of humic acids, the alkali content, and solubility in water. But the main goal of the study is to study the biological activity of the activity, which is associated with the determination of the germination of cucumber seeds, the size of the stems, roots and weight of plants under the influence of humic substances compared with an increase in the number of cucumber seeds in water. Analysis of the yield as a result of the experiments showed that the preparations for the study of properties have a high biological activity, which allows them to be used as plant growth stimulants. Therefore, the application of humic agrochemicals in agriculture as a result of plant infection and plant growth will be highly effective.

1 Introduction

Russia has 10% of all arable land in the world, but at the same time, experts note a low level of use of agricultural potential. Desertification of the countryside is observed in the regions, vast areas of agricultural land are abandoned, despite the current rather high level of productivity, erosion processes are developing, fertility is declining and humus is being lost, soils are compacted, etc.

Most of the problems with soil fertility and quality are solved by applying organic and inorganic fertilizers to the soil. Humic acids are one of the types of organic fertilizer with a wide spectrum of action [2-4]. The advantages of humic preparations lie in the possibility of reducing the consumption of mineral fertilizers without damage to the crop due to increased absorption of nutrients and in the ability to significantly reduce the amount of pesticides used without reducing their effectiveness, which is extremely important, both in economic and environmental aspects [5-7].

Humic substances form the basis of soil fertility because they are part of it. The formation of humic substances occurs during the decay of plant and animal residues under the action of microorganisms and abiotic environmental factors. In addition to soil, humic

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substances are found in sea and river water, bottom sediments, soil, peat and brown coal. From humic substances, humates are obtained, which are water-soluble salts of humic acids.

To obtain humates, various methods and technologies have been developed and implemented. The number of manufacturers of this type of agrochemical and agronomic preparations is growing [8–10]. These preparations have a different origin both in terms of the type of raw materials and the technology used to obtain them, which affects their effectiveness when used in agriculture.

In order to determine the physicochemical properties and biological activity of dry humates, samples of preparations produced on an industrial scale were selected and experimentally studied in the laboratory.

2 Materials and methods

For the experimental part of the work, samples of substances intended for household plots were taken as objects of study:

- Sample 1: plant growth stimulant (environmentally friendly), potassium humate.
- Sample 1: potassium humate fertilizer, an environmentally friendly plant growth stimulator.
- Sample 2: complex organomineral fertilizer plus 9 trace elements.
- Sample 3: fertilizer with trace elements, humate plus 7 trace elements and iodine, grade A.
- Sample 4: fertilizer based on natural humic acids with a high content of humates.
- Sample 5: fertilizer based on humic acids grade A.
- Sample 6: complex organomineral fertilizer, humate plus 7 trace elements.
- Sample 7: fertilizer based on humic acids, concentrate of the active part of humus plus 7 trace elements, grade C1.

Regardless of the feedstock and production technology, agrochemicals based on humic acids contain a large set of trace elements that pass into their composition from the feedstock, which is most often brown coal and peat.

The information provided by the manufacturer does not contain indications of the feedstock from which the humates were obtained.

An analysis of the information given by manufacturers on the labels showed that there is practically no indication of the raw materials for production. Indirectly, we can say that samples 3, 5 and 7 are made from peat and are labeled according to GOST R 54249-2010. The chemical composition of the samples according to the manufacturer's data (mass fraction of substances, % not less than):

- Sample 1: humic substances (50).
- Sample 2: humic substances (70), N (5), P (5), K (5), trace elements: Cu (0.2), Mn, Zn, Mo, Co, B, Fe, Ca, Se.
- Sample 3: mixture of potassium and/or sodium salts of humic acids (75), K (5), Cu (0.2), Zn (0.2), Mg (0.17), I (0.005), Mo (0.018), Co (0.02), Fe (0.4), B (0.2).
- Sample 4: mixture of potassium and/or sodium salts of humic acids (85), K (5), N (1.5), Si (2).
- Sample 5: salts of humic acids (78).
- Sample 6: Humate (40), N (1.5), K (5), Cu (0.2), Mg (0.3), Fe (0.45), Zn (0.2), Mo (0.04), Co (0.02), B (0.5).
- Sample 7: Humate (75), K (5), Cu (0.2), Mn (0.17), Zn (0.2), Mo (0.018), Co (0.02), B (0. 2), Fe (0.4).

The description and composition correspond to the data given by the manufacturer on the product label.

The samples listed above were studied on the basis of GOST R 54221-2010. The study of the physicochemical properties of the samples was carried out for the agrochemicals accepted for the study when they were diluted in proportions according to the scheme recommended by the manufacturer for soaking the seeds or, in the absence of such recommendations, then in the concentration for watering the plants.

The main purpose of the study is to study the biological activity of the preparations, which was determined by determining the germination of cucumber seeds, the size and weight of sprouts in a humate medium compared to distilled water. Testing of biological activity was carried out for two concentrations of the solution. The first group of solutions when diluted in proportions as recommended from the manufacturer's label for soaking seeds. For samples without soaking recommendations - at the concentration for watering plants, that is, the same concentration as when determining the physico-chemical properties. In addition, to determine the biological activity, additionally, based on the results of determining the yield of free humic acids, solutions of all samples with a concentration of 0.1 g/l of humic substances were diluted to level the effect of their concentration on this parameter.

3 Results

The results of studying the physical and chemical properties of samples of dry humic agrochemicals and their biological activity are shown in Tables 1-4.

Table 1. The concentration of humic acids in solutions of agrochemicals after dilution according to the manufacturer's instructions.

Sample	Recommended amount of agrochemical per 1 liter of water, g	pH	The concentration of humic substances	Purity of humic substances
Sample 1	0.2	8.21	0.100	1 : 1
Sample 2	0.4	8.75	0.350	1 : 0.1
Sample 3	1.0	8.37	0.278	1 : 2.6
Sample 4	1.0	8.72	0.458	1 : 1.2
Sample 5	0.1	7.88	0.045	1 : 1.2
Sample 6	0.5	8.40	0.169	1 : 2.0
Sample 7	1.0	8.64	0.396	1 : 1.5

Table 2. Physical and chemical properties of samples after breeding according to the manufacturer's instructions for pre-sowing seed treatment.

Sample	Ash content of humic substances, %	Solubility, %	Alkali content, g/l	Optical density (wavelength, nm)
Sample 1	0.0001	99.63	0.1375	0.606 (450)
Sample 2	0.0042	99.93	0.1625	0.37 (450)
Sample 3	0.0165	99.65	0.1000	1.93 (450)
Sample 4	0.0297	99.91	0.0250	0.821 (600)
Sample 5	0.0036	99.86	1.5256	0.24 (450)
Sample 6	0.0050	99.89	1.6000	1.224 (600)
Sample 7	0.0033	99.65	0.0400	0.748 (600)

Table 3. Biological activity of humic preparations when diluted according to the manufacturer's instructions.

Sample	Change in seed germination, %	Biological activity, %		
		by root length	along the length of the stems	by weight of plants
Sample 1	3.15	5.82	20.34	11.17
Sample 2	0.00	-9.12	2.96	0.50
Sample 3	11.11	40.33	10.66	10.07
Sample 4	2.22	20.39	19.76	19.66
Sample 5	6.67	15.26	5.74	2.95
Sample 6	1.48	24.64	16.39	16.19
Sample 7	8.15	23.21	22.79	11.38

Table 4. Biological activity of humic preparations at a concentration of humic substances of 0.1 g/l.

Sample	Change in seed germination, %	Biological activity, %		
		by root length	along the length of the stems	by weight of plants
Sample 1	3.15	5.82	20.34	11.17
Sample 2	2.22	5.22	4.93	7.27
Sample 3	0.00	32.60	17.20	15.34
Sample 4	-1.11	21.90	7.43	21.60
Sample 5	0.00	24.12	10.54	16.33
Sample 6	5.56	28.17	2.75	4.39
Sample 7	-1.11	16.20	9.82	10.97

4 Discussion

Agrochemicals from different manufacturers, when diluted according to the working solution scheme, differ in appearance not only in color intensity (from light to dark), transparency (from transparent to cloudy), but also in color (from bright brown, brown-red to black). -brown). At the same time, the concentration of humic substances in these solutions differs ten times from each other: from 0.045 (sample 5) to 0.458 (sample 4).

The purity of humic substances in the studied preparations is shown by the quantitative ratio of humic substances to the non-humic component in a dry agrochemical (Table 1). Sample 2 has the least contamination with foreign substances, sample 3 has the highest. The non-humic component of these agrochemicals can include both useful impurities (trace elements or fulvic acids) and residual coal or peat, which constitute the ballast for preparations.

The investigated humic agrochemicals are characterized by high solubility (more than 99.6%) and low ash content of the humic component (from 0.0297% or less) (Table 2), which indicates a low content of ballast particles. Samples 5 and 6 have a high alkali content (more than 1.5 g / l) compared to other preparations, but when diluted, alkalinity does not give overestimated pH values in solutions, the pH of all solutions diluted in the concentration of the manufacturer is not less than 7.8, which is the norm for dissolving humic acids in water.

The results of testing the studied samples of dry humic-containing agrochemicals for biological activity by determining the germination of cucumber seeds, the size and weight of the sprouts are shown in Tables 3 and 4.

In terms of germination, the best results were obtained for almost all samples diluted in the concentration proposed by the agrochemical manufacturer.

According to the increase in the length of the root, the length of the stem and the mass of seedlings, only sample 2 at the concentration of the producer has a negative value (growth inhibition). This sample showed a slight increase in all studied parameters in both concentrations. At the same time, it can be seen that sample 3 has the best results in both

concentrations in terms of root growth, sample 1 in stem length growth, and sample 4 in weight gain. The test showed that seedlings are not sensitive to such changes. in the concentration of humic preparations. For example, sample 4: 4.5 times difference in concentration, but the result is relatively high in both cases; sample 3: concentration difference 2.8 times, but the result is relatively low in both cases.

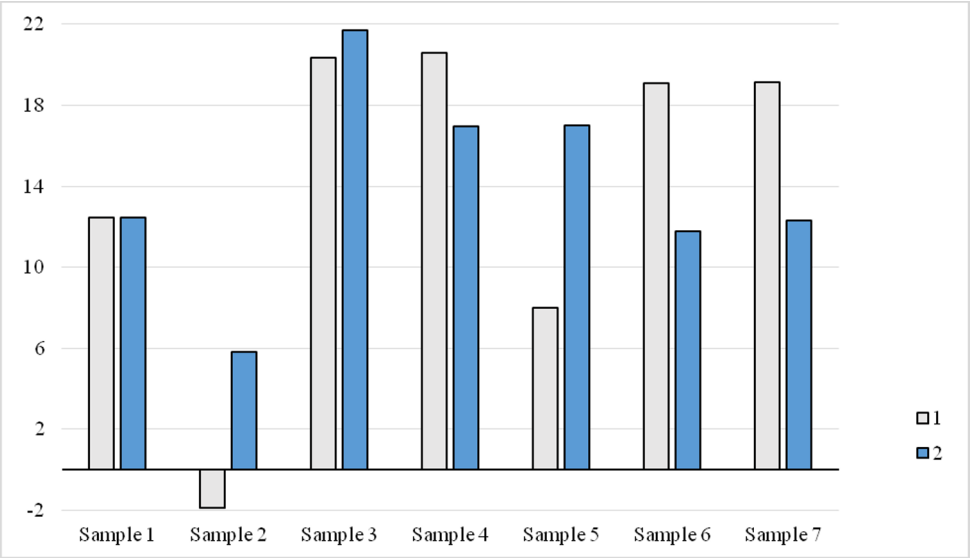

Fig. 1. Average biological activity of dry agrochemicals: 1 - tested solutions of agrochemicals are diluted according to the manufacturer's instructions; 2 - tested solutions of agrochemicals are diluted at a concentration of 0.1 g/l.

Comparison of the test results for one concentration (Table 4) shows that only sample 3 has a biological activity of more than 15% for all three indicators, and sample 3 and sample 6 have a concentration recommended by the manufacturer.

The figure shows a comparison of the average biological activity for three indicators. It is clearly seen that for samples 2, 3 and 5 the biological activity of the preparations when diluted at a concentration of 0.1 g/l is higher, and for samples 4, 6 and 7 it is lower.

5 Conclusion

Experimental data showed that the highest results belong to samples 3 and 6. The obtained indicators of the increase in the size and weight of the sprouts make it possible to classify the preparations of samples 3 and 6 as growth stimulants, because their biological activity is more than 15% for all three indicators.

An analysis of the data obtained as a result of the experiments showed that the preparations, according to the studied properties, for the most part have a high biological activity, which allows them to be used as plant growth stimulants. Therefore, the use of humic-containing agrochemicals in agriculture in order to accelerate the development and growth of the plant will be highly effective. Due to the large number of influencing factors, it is necessary to study this class of agrochemicals in more depth and comprehensively and to accumulate the data obtained, preferably in relation to "raw materials - composition - properties - biological activity".

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