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Fertilizers, Growth Regulators and Biochemical Composition of Plant.

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ABSTRACT

The article presents the results of studies on the use of mineral fertilizers and plant growth regulators on maize for the production of environmentally friendly products. It is found that the foliar treatment of maize plants with growth regulators did not lead to the accumulation of nitrate nitrogen in the biomass. When using Zircon, Krezatcin and Albite at all levels of mineral nutrition there was an increase in the concentration of lead in plants 1,1 ... 1,4 times. When processing crops with Zircon there was observed an increased (by half) plants cadmium uptake, but in all cases the cadmium content did not exceed the maximum permissible level.
Keywords: mineral fertilizers, growth regulators, maize, protein, nitrates, trace elements.

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INTRODUCTION

At present, the ecological state of the environment forces to search for new and safe methods of increasing productivity and improving the quality of agricultural products. In these conditions biological crop protection and growth stimulation methods acquire great value (2, 3, 5). Growth regulators are essential in the formation of plant productivity, which have become an important element of modern technologies in agricultural production (8, 11, 13, 16). The plant growth regulators on natural basis are harmless, environmentally safe and highly effective at low doses biologically active substances. They are able to stimulate the growth and generative processes of plants and to increase their adaptive capacity in adverse environmental conditions (1, 4, 6, 7, 9). Due to the low doses of use, growth regulators can be considered low-cost elements of farming, which makes them attractive from an economic point of view (12, 14, 15). In recent years highly effective plant growth regulators for increasing yield and improving product quality were synthesized, however, their influence on the yield and quality of maize is not sufficiently studied. The synthesis of new products involves increasing their environmental safety and the establishment of energy-saving technologies of production and application, which determined the purpose of the research.

THE METHODOLOGY OF RESEARCH

The studies were conducted in 2013 - 2015 years in the conditions of the closed joint-stock company "Konstantinovo" in Penza region. The two-factor field experience (A × B) was laid out in four replications by the split plots under the scheme:

Factor A - the dose of fertilizer: 1 - N0P0K0; 2 - N120P104K60 (calculated dose of fertilizer on the yield of green mass 40.0 t / ha); 3 - N150P130K75 (calculated dose of fertilizer on the yield of green mass 50.0 t / ha).

Factor B - foliar treatment with growth regulators (in the phase of 5-leaf corn): 1 - without treatment (control); 2 - Epin-Extra (0,040 l / ha); 3 - Zircon (0.030 l / ha); 4 - Ribav- Extra (0,001 l / ha); 5 - Krezatcin (0.010 l / ha); 6 - Albite (0,040 l / ha). The area of the plots of the first order is 168 m2, of the second -28 m2. The object of research - corn hybrid Katerina SV (FAO 170). The sowing was carried out with inter-row spacing of 70 cm. Plant density was 80 thousand. / ha. The use of mineral fertilizers: ammonium nitrate, double superphosphate, potassium chloride. The predecessor - winter wheat on a clear fallow. The soil of pilot area is moderately leached heavy loam middle-humous black soil on the integumental calcareous loam with humus content - 5,1 ... 5,3%; mobile phosphorus 108 ... 117; exchangeable potassium 148 ... 157 mg / kg of soil; soil acidity was 5.30 ... 5.41.

THE RESULTS OF THE STUDY

The biochemical analysis of corn harvested in the phase of milky-wax ripeness, showed that the most protein comprising biomass was obtained when processing crops with Zircon on all backgrounds of mineral nutrition. The protein content was 9.40%. The greater impact on the accumulation of the protein in plants has had the use of of mineral fertilizers. With the increase of mineral fertilizers doses the protein content had increased by 1.11 ... 1.70% (Table. 1). It was found that improving soil food mode the fiber content of plants had decreased by 0.98 ... 2.00%, which made it possible to get a well digestible feed. The growth regulators treatment had no impact on the quality index. It should be noted that the average of research during the years in plants there accumulated 2.56 ... 2.96% fat in dry matter, but no significant differences were observed over the years of research and experience variations. The total amount of ash characterizes mineral nutrient of a feed. In the plant feeds there are few ash substances. The ash content of obtained biomass ranged from 4.72 to 5.20% of dry matter, which was slightly below the zootechnical standards. The studied maize cultivation methods had no significant effect on the ash content in plants. The major part of nitrogen-free plant extractives (NFPE) comprise carbohydrates - soluble (sugar) and insoluble (starch). They have the greatest importance in the diet of animals as they define a power supply level in a body. During the years of investigations there was obtained the biomass with NFPE contain of 62,45 ... 63,10% in dry matter. Regular variation of the NFPE concentration in dry matter, depending on the doses of fertilizers and growth regulators is not revealed. It is important that plant biomass containes the least amount of nitrates. It was found that in conditions of an unfertilized background the plants accumulated the least amount of nitrates in all cases. When applying mineral fertilizers it naturally increased in proportion to the added doses. In the first case of mineral fertilizers ap-

plication the content of nitrate nitrogen the plants has increased, on average, four times, and in the second - six times as compared to the natural soil fertility, but it did not exceed the maximum allowable concentrations (Fig. 1). The growth regulators treatment did not lead to an increase in nitrate nitrogen in the green mass.

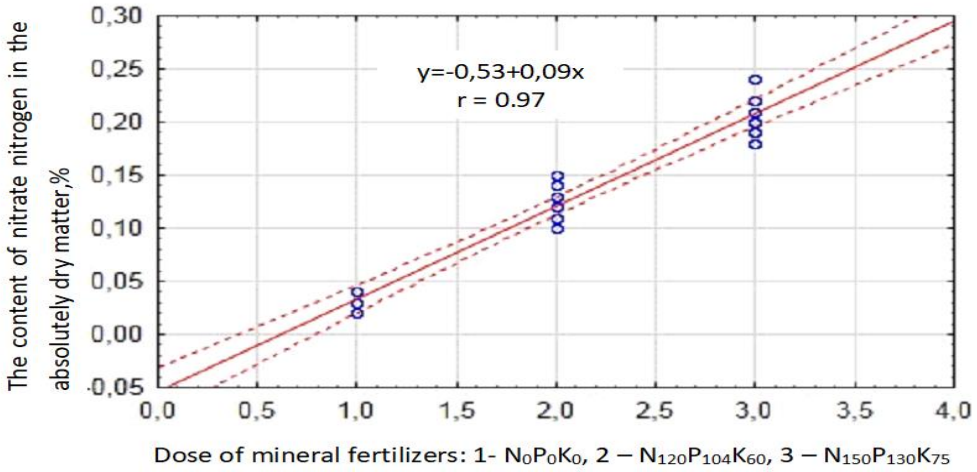

Figure 1 - The effect of of mineral fertilizers on the plant accumulation of nitrate nitrogen.

The accumulation of potassium by dry biomass of corn, as shown by our study, mainly depends on the dose of fertilizer. Thus, applying N150R130K75 the potassium content increased, as compared with unfertilized background to 0.14 ... 0.25%. During all the years of research there was produced a feed with the excess of the animal optimal potassium level of 1.6 ... 1.9 times. The results of the study show that increasing the dose of fertilizer increased the phosphorus content in plants to 0.26 ... 0.30% on an unfertilized background, to 0.32 ... 0.36% with fertilizer. Plants foliar treatment with growth regulators had no impact on the accumulation of potassium and phosphorus in the product.

Maximum protein gather was obtained on a fertilized background with additional crops processing with Krezatcin and Albite - 893 ... 962 kg / ha. The increase when spraying the crops with these growth regulators was 28.2 ... 28.6% on natural fertility and 11.7 ... 14.4% applying mineral fertilizers. On the background of N120R104K60 the collection of digestible protein increased in the average by 47.4 ... 61.5%. The further improvement in the root feeding conditions did not lead to a proportional increase in the collection of digestible protein. Energy provision of animal rations is important now. In the years of research there was received enough energy saturated biomass, the energy supply in different years varied insignificantly and ranged from 10.7 to 11.5 MJ / kg of dry matter (Fig. 2).

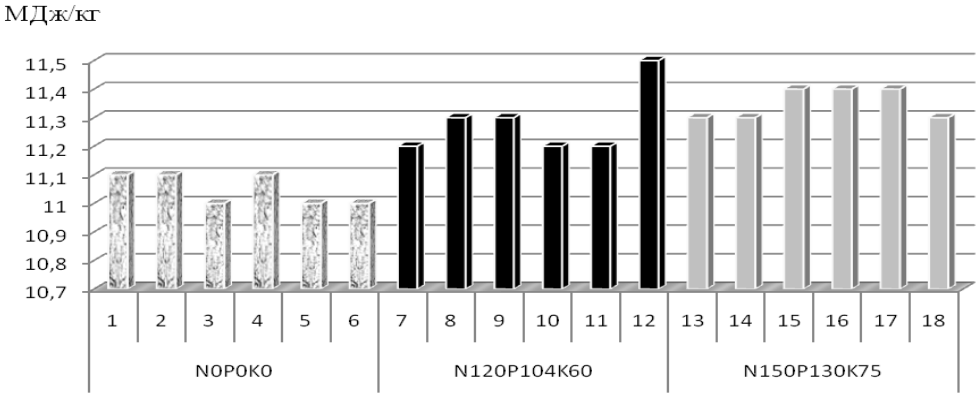

Figure 1 – Influence of methods of cultivation on the energy value of corn, 2013...and 2015
Note: factor B – growth regulators – 1, 7, 13 – no treatment; 2, 8, 14 – Epin-Ekstra; 3, 9, 15 – Zircon; 4,10,16 – Ribav-Extra; 5, 11, 17 – Krezatsin; 6, 13, 18 – Albite.

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Table 1: The biochemical composition of maize, 2013 ... 2015.

Factor A – fertilizer dose	Factor B – growth regulators treatment	Content in absolutely dry matter,%							
		protein	fiber	fat	ash	NFES	$N\text{-}NO_3$	Phosphorus	potassium
N0P0K0	No treatment	7,60	21,86	2,70	4,79	63,06	0,03	0,26	1,62
	Epin-Extra	7,67	21,38	2,72	5,13	63,10	0,04	0,25	1,63
	Zircon	7,91	21,63	2,64	5,16	62,66	0,02	0,30	1,67
	Ribav-Extra	7,75	21,62	2,56	5,20	62,88	0,03	0,27	1,67
	Krezatsin	7,58	21,86	2,75	5,05	62,75	0,03	0,28	1,61
	Albite	7,55	22,18	2,79	4,72	62,76	0,04	0,30	1,75
N120P104K60	No treatment	8,71	21,00	2,90	4,76	62,63	0,11	0,30	1,79
	Epin-Extra	8,84	20,54	2,88	4,85	62,89	0,13	0,30	1,80
	Zircon	9,13	20,65	2,61	4,94	62,46	0,15	0,33	1,75
	Ribav-Extra	8,77	20,73	2,77	4,73	63,00	0,10	0,32	1,82
	Krezatsin	8,77	20,78	2,95	5,04	62,45	0,14	0,32	1,80
	Albite	8,94	20,88	2,95	4,60	62,63	0,12	0,33	1,87
N150P130K75	No treatment	9,03	20,37	2,87	4,79	62,93	0,19	0,33	1,86
	Epin-Extra	8,96	20,24	2,93	4,98	62,90	0,18	0,33	1,84
	Zircon	9,40	19,93	2,82	4,78	63,07	0,24	0,33	1,83
	Ribav-Extra	9,13	20,11	2,83	4,96	62,97	0,20	0,32	1,88
	Krezatsin	9,26	20,00	2,92	4,87	62,95	0,22	0,36	1,86
	Albite	9,25	20,18	2,96	4,95	62,66	0,21	0,36	1,89

Nitrogen-free extractive substances - БЭВ

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Table 2: The content of microelements in plants of maize, 2013 ... 2015

Factor A – fertilizer dose	Factor B – growth regulators treatment	Absolutely dry matter content, mg / kg					
		Cu	Zn	Mn	Fe	Pb	Cd
N0P0K0	No treatment	3,9	14	54	27	5,0	0,052
	Epin-Extra	3,2	12	81	21	4,8	0,028
	Zircon	2,5	12	64	34	5,6	0,071
	Ribav-Extra	2,1	15	68	21	4,8	0,061
	Krezatsin	2,8	8	71	37	5,1	0,065
	Albite	3,0	7	67	20	5,3	0,032
N120P104K60	No treatment	3,5	7	58	28	4,4	0,045
	Epin-Extra	3,6	9	61	37	4,7	0,074
	Zircon	3,7	14	74	34	5,2	0,078
	Ribav-Extra	3,1	16	65	31	4,9	0,029
	Krezatsin	2,8	15	58	29	7,0	0,035
	Albite	2,5	12	56	18	4,6	0,029
N150P130K75	No treatment	2,6	13	67	19	4,3	0,031
	Epin-Extra	2,1	6	72	24	5,1	0,069
	Zircon	3,1	8	64	26	6,4	0,052
	Ribav-Extra	3,2	14	58	37	6,0	0,035
	Krezatsin	3,0	16	54	34	5,1	0,032
	Albite	2,7	18	53	22	5,1	0,094
MPL (maximum permissible level)		30	50	-	100	5	0,3
Optimum in feeds		10	20	60			

There is a tendency of improving biomass energy supply during the improvement of root nutrition conditions when applying mineral fertilizers. The growth regulators did not have a positive impact on the energy intensity of dry biomass. The calculation showed that the maximum yield of the exchange energy is obtained when spraying crops with Krezatcin and Albite on the background of mineral fertilizers in N150R130K75 dose - 178.2 ... 181.0 GJ / ha, which is 23.2 ... 25.2% higher than the unfertilized background. Similar variations in the background of N120R104K60 are practically the same - the output of the exchange energy is higher than the background of natural fertility by 21.8 ... 22.1%.

It is known that trace elements increase the yield and production quality of crops, prevents the development of certain diseases. But any food items, that are in excess, can be toxic and cause damage to all living things. It is necessary to minimize the level of heavy metals in the human body, in particular, by obtaining crop production produce (food for humans and livestock, which in turn are also a source of food for humans) free from heavy metal contamination (10). However, not all the elements are toxic, because copper (Cu) and zinc (Zn) in optimum concentrations are plant nutrient elements. The chemical analysis showed that the copper concentration in the plants when applying mineral fertilizers for the planned yield of 40 t / ha increased from 2.9 to 3.2 mg / kg of dry matter, but the further increase in the dose of fertilizer helped to reduce the copper content to 0, 4 mg / kg (Table. 2). No dependence of copper concentration in plants from foliar treatment with growth regulators have been identified. Which ever of the concentration of copper in the plants is not revealed by foliar treatment of growth regulators. The zinc content in the plants was in the range of 7 ... 18 mg / kg of dry matter. It has been established that the treatment with Albit and Krezatcin on the background of natural fertility and the treatment of Epin-Extra on the background of of mineral fertilizers, as well as for foliar

treatment of Zircon on the increased mineral nutrition background marked zinc deficiency in the plants. While improving the conditions of mineral nutrition there was an increase in the concentration of zinc in the plants in the processing of crops with Ribav-Extra, Krezatcin and Albite, but in the all cases of the experience the zinc content in feeds was below the optimum . When improving the conditions of root nutrition the concentration of manganese (Mn) in the plants was reduced by 5.5 and 6.2 mg / kg of dry matter, respectively to the backgrounds of fertilizer. The maximum concentration of manganese in the plants was marked on foliar treatment embodiments with Epin-Extra - 72 ... 81 mg / kg of dry matter. On the unfertilized background in all variants with the growth regulators manganese accumulated in quantities exceeding the optimum in feeds. When using mineral fertilizers, this tendency remained in versions with Zircon and Epin-Extra. In foliar corn treatment the intake of iron with Albite (Fe) was minimal compared to the other the growth regulators - 18 ... 22 mg / kg of dry matter. The maximum iron content in plants accumulated during the processing with Krezatsin on the background of natural fertility, with Epin-Extra on the ground level of a mineral nutrition and with Ribav-Extra on the second level of a mineral nutrition - 37 mg / kg of dry matter. It should be noted that the iron concentration in feeds was 1,8 ... 3,7 times less than the maximum permissible level (MPL). Foliar treatment of maize plants with Zircon, Krezatsin and Albite at all levels of the mineral nutrition contributed to the strong absorption of lead (Pb) and an increase in its concentration in plants 1,1 ... 1,4 times in comparison with the variants without the use of growth regulators. The investigation of the dynamics of cadmium (Cd) accumulation in corn plants showed that the application of mineral fertilizers for the planned yield of 40 t / ha reduced 1.1 times its concentration in the feed, the subsequent increase in the dose of mineral fertilizers contributed to an increase in the cadmium content to the level marked on the background of natural fertility. At all levels of mineral fertilizers there was marked an increased (by half) uptake of cadmium during the processing crops with Epin-Extra and Zircon compared to variants without a growth regulator, but the cadmium content did not exceed the maximum permissible level in obtained plant products.

CONCLUSION

- The improvement of soil nutrient status in the application of mineral fertilizers had a greater impact on the biochemical composition of corn, growth regulators did not cause significant changes in the biochemical composition of plants.
- Crops foliar treatment with growth regulators did not lead to an increase in nitrate nitrogen in corn plants.
- There is a trend to improve the biomass of maize, as the conditions of the root meal improve when mines are introducedeHeadquarters fertilizer.
- Foliar treatment of corn plant with Zircon, Krezatsin and Albite at all levels of the mineral nutrition increased 1,1 ... 1,4 times the concentration of lead in plants.
- At all levels of the mineral nutrition there was marked an increased (by half) absorption of cadmium during crops processing with Epin-Extra and Zircon in comparison to variants without a growth regulator, but in all cases the cadmium content in biomass did not exceed the maximum permissible level.

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