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## CROP PRODUCTION

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### INFLUENCE OF MINERAL FERTILIZERS AND GROWTH REGULATORS FOR MAIZE YIELD

Research article

#### Abstract

The article presents the results of studies on the effect of the combined use of mineral fertilizers and growth regulators of various spectra of action on the yield of various hybrids of corn cultivated for grain in the conditions of the Central Black Earth Plant. Differences in the responsiveness of hybrids to increasing doses of applied fertilizers and applied agrochemicals were established. The most productive maize hybrids have been identified. The efficiency of the combined use of increasing doses of mineral fertilizers and various plant growth stimulants, new forms of macro- and micronutrient fertilizers, physiologically active substances in the formation of grain corn yield is presented.

**Keywords:** maize hybrids, yield, mineral fertilizer, fertilizer level, agrochemicals, non-root top dressing

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### ВЛИЯНИЕ МИНЕРАЛЬНЫХ УДОБРЕНИЙ И РЕГУЛЯТОРОВ РОСТА НА УРОЖАЙНОСТЬ КУКУРУЗЫ

Научная статья

#### Аннотация

В статье представлены результаты исследований по влиянию совместного применения минеральных удобрений и регуляторов роста различного спектра действия на урожайность различных гибридов кукурузы, возделываемой на зерно в условиях ЦЧЗ. Установлены различия в отзывчивости гибридов на повышение доз вносимых удобрений и применяемых агрохимикатов. Выявлены наиболее продуктивные гибриды кукурузы. Представлена эффективность совместного применения возрастающих доз минеральных удобрений и различных стимуляторов роста растений, новых форм макро- и микроудобрений, физиологически активных веществ в формировании урожая кукурузы на зерно.

**Ключевые слова:** гибриды кукурузы, урожайность, минеральное удобрение, уровень удобренности, агрохимикаты, некорневые подкормки.

#### 1. Introduction

In all countries of the world with highly developed agriculture, at least half of the increase in crop production is obtained by applying mineral fertilizers. Mineral fertilizers are available, and will remain in the foreseeable future one of the main levers of increasing crop productivity [1, P.212-215], [2, P.321-329].

The dependence of crop productivity on fertilizer doses is mainly non-linear and has three zones of action: kinetic, physiological, and a zone of action in which growth is inhibited and productivity is reduced [3, P.187-190]. It is usually recommended to use such doses of fertilizers that "work" in the first two zones. For various regions of our country, the maximum permissible environmentally safe doses of fertilizers for agricultural crops have been determined, ensuring acceptable yields with satisfactory product quality [4, P.213-226]. The fertilizer application system should not be developed as a whole for any crop, but taking into account the characteristics of a particular hybrid or variety. This makes it possible to use mineral fertilizers more efficiently and more accurately reveal the potential of productivity and quality of a hybrid or variety [5, P. 42-48].

Also, one of the important components of modern crop production technologies are growth regulators – natural and synthetic organic compounds that in small doses actively affect the metabolism of plants, leading to noticeable changes in growth and development [6, P.47-51]. In modern conditions, the use of growth regulators is becoming very important. This is due to the active search for new, more effective ways and methods to increase the productivity of the agricultural sector of the economy, primarily due to low-cost technologies [7, P. 3-6].

## 2. Research methods

Research on the effect of various agrochemicals on the yield of various maize hybrids was carried out in a three-factor stationary experiment of the Department of Agrochemistry on ordinary medium – humus heavy – loam granulometric composition with the following agrochemical characteristics in a layer of 0-40 cm: humus – 6.39; pH of salt extract-6.0, hydrolytic acidity – 1.67 mg-EQ./100 g, the sum of absorbed bases – 46.12 mg – EQ./100 g of soil, gross nitrogen content – 0.297 %, phosphorus-0.170 %, potassium-1.82 %. The content of mobile forms of phosphorus and potassium varies, respectively, from 70 to 120 and from 65 to 115 mg / kg of soil.

Scheme of experience. Scheme of experience: Factor A includes four options for fertilization with mineral fertilizers: 1. - control (without fertilizers), 2. – 0.5 recommended dose (N30P30K30), 3.– 1.0 recommended dose (N60P60K60) and 4. - 1.5 recommended dose (N90P90K90). Corn is the 7th crop rotation crop. During the period of the stationary experiment (from 2011-13 to 2017-19), the following amounts of fertilizers were added to the experiment variants: 1. – N0P0K0, 2. – N170P170K170, 3. –N380P320K320, 4. - N630P450K450. Factor B includes 5 options with the use of various agricultural products, in the form of two-fold foliar feeding: 1. - without agrochemicals, 2. - Lignohumate, 3. - S. Progen growth, 4.- Aquadon – micro, 5.-Gumi-20m rich. Factor C includes 6 hybrids of the studied culture. The following hybrids were presented in the experiment with corn: Dokuchaevsky 1, dokuchaevsky 250, dokuchaevsky 220, dokuchaevsky 190, SI Phenomenon I, SI Rotango. The first four hybrid breeding CCP NIISKH im. V. V. Dokuchaev, the other two hybrid – foreign company Syngenta.

The experience is repeated three times. The arrangement of plots is systematic. Agrotechnics of cultivation of all crops of experience – in accordance with the recommendations for the Voronezh region. The experimental data were subjected to analysis of variance according to B. A. Dospehov.

## 3. Results and discussion

The experimental data obtained for the period 2017-2019 indicate that the most effective factor determining the value of corn yield is the level of fertilization with mineral fertilizers (table 1).

Table 1 – corn Yield at various levels fertilizers (2017-2019), t / ha

Level fertilization (factor A)	Hybrids (factor C)						Average for all hybrids
	Dokuchaevsky 220	Dokuchaevsky 190	Dokuchaevsky 250	Dokuchaevsky 1	SI Phenomenon	SI Rotango	
N <sub>0</sub> P <sub>0</sub> K <sub>0</sub>	4,05	4,15	3,63	4,00	4,59	4,67	4,18
N <sub>30</sub> P <sub>30</sub> K <sub>30</sub>	4,82	4,80	4,30	4,44	5,29	5,61	4,88
N <sub>60</sub> P <sub>60</sub> K <sub>60</sub>	5,72	5,84	4,69	5,22	6,22	6,31	5,67
N <sub>90</sub> P <sub>90</sub> K <sub>90</sub>	5,93	6,18	4,97	5,72	6,96	6,90	6,11
NDS <sub>095</sub> (factor C),	0,34 t/ha						

The dose of fertilizers N30P30K30 in comparison with the windless background provided an increase in grain collection by 0.70 t/ha. Increasing the fertilizer dose to N60P60K60 led to a further increase in corn productivity by 1.49 t / ha, and bringing the level of fertilizer to N90P90K90 provided an additional increase in yield to 1.93 t / ha. At all levels of fertilization, hybrids of foreign selection SI Phenomenon and SI Rotango were the most productive. With the smallest lag in performance compared to foreign hybrids, the recently zoned new hybrid Dokuchaevsky 190 should be noted. Its productivity was lower in comparison with foreign hybrids by 0.44 and 0.52 t / ha, on the background of increased fertilization (N30P30K30) – 0.49 and 0.81 t/ha, on the background of average fertilization (N60P60K60) – 0.38 and 0.47 t/ha, and on the variants of high fertilization (N90P90K90) – 0.78 and 0.72 t/ha. Subsequent hybrids of local selection are even more significantly inferior in yield to hybrids of the foreign company Syngenta.

The inclusion of two non-root feedings with agro-products in the technology of maize cultivation contributed to a significant increase in grain yield. The effectiveness of various agrochemicals varied significantly depending on the doses of mineral fertilizers applied to corn and the levels of fertilization of this crop as a whole. Against an unsubstantiated background, the highest indicators were when applying the agro-product Gumi-20MG. The increase in grain yield from its use was 0.67 t / ha. Then, in descending order of effectiveness, the preparations were placed in the following sequence: Aquadone-micro-0.45 t / ha, Lignohumate-0.38 t / ha and S. Progen growth-0.15 t / ha. Lignohumate showed the highest efficiency in the variants with the n30p30k30 fertilization level. The increase in grain yield from its application was 0.61 t / ha. The following agro-products are Gumi-20M rich 0.57 t / ha, Aquadon-micro 0.38 t / ha and S. Progen growth 0.31 t / ha. Against the background of N60P60K60, the line of efficiency of agricultural products was distributed as follows: Aquadon-micro-0.69 t / ha; Lignohumate-0.65 t / ha; Gumi-20M rich-0.55 t / ha, S. Progen growth-0.46 t / ha. Against the background of N90P90K90, Lignohumate was the most effective drug. The increase in grain yield from its application was 0.49 t / ha, followed by Gumi-20M rich-0.44 t / ha, S. Progen growth-0.37 t / ha and closes the list of Aquadon-micro-0.36 t / ha.

On average, regardless of the background fertilization of corn, the most effective showed Gumi-20M rich. The increase in grain yield from its application was 0.56 t / ha. Further, in descending order of effectiveness, the preparations were placed in the following sequence: Lignohumate-0.53 t / ha; Aquadone-micro-0.47 t / ha; S. Progen growth-0.32 t / ha.

Comparing the efficiency of mineral fertilizers and areprepared, it should be noted that on the background of unfertilized N0P0K0 application studied in the experiment of areprepared approaches in their effectiveness to the dose of mineral fertilizers N30P30K30 and N60P60K60 background the use of these drugs is approaching in their effectiveness to the dose of mineral fertilizers N90P90K90.

Considering the effectiveness of agricultural products in the context of different maize hybrids, it should be noted that their shares in the formation of grain yield increases of different hybrids were slightly different (table 2).

Table 2 – Effectiveness of agrochemicals on various hybrids corn (2017-2019), t / ha

Agrochemicals (factor B)	Hybrids (factor C)						On average for all agricultural products
	Dokuchaevsky 220	Dokuchaevsky 190	Dokuchaevsky 250	Dokuchaevsky 1	SI Phenomenon	SI Rotango	
Without agrochemicals	4,60	4,75	4,24	4,48	5,50	5,40	4,83
Lignohumate	5,27	5,45	4,51	4,97	5,98	6,00	5,36
S. Progen growth	5,23	4,98	4,35	4,84	5,72	5,79	5,15
Aquadon-micro	5,21	5,49	4,40	5,03	5,80	5,87	5,30
Gumi-20M rich	5,25	5,55	4,48	4,90	5,85	6,29	5,39
NDS <sub>095</sub> (factor B),	0,21t/ha						

On the Dokuchaevsky 220 hybrid, Lignohumate showed the greatest effectiveness. It provided an increase in productivity by 0.67 t / ha. On the Dokuchaevsky 190 hybrid, the largest increase in grain yield was provided by Gumi-20 MT - 0.80 t / ha. On the hybrid Dokuchaevsky 250-Lignohumate-0.27 t / ha. On the hybrid Dokuchaevsky 1-Aquadon-micro-0.55 t / ha. The leading position in increasing the yield of the SI Phenomenon hybrid was taken by Lignohumate – 0.48 t/ha, and the SI Rotango – Gumi hybrid-20MG-0.89 t / ha. Also, by calculation, the share of influence of each factor on the productivity of corn was determined. Factor A (level of fertilization) -46.37%, factor B (agricultural products)-12.4%, factor C(varieties) - 24.67%.

The content of starch and protein in corn hybrids at different levels of fertilization with mineral fertilizers is shown in table 3. The results of the analysis show that the increase in the level of corn fertilization from N0P0K0 to N90P90K90 practically had no effect on the change in the starch content in the grain, however, there is a barely noticeable trend of increasing its content in hybrids of domestic selection and reducing it in foreign hybrids.

Table 3 – Quality indicators of corn grain at various levels of fertilization (2017-2018), % abs. dry. in the Islands

Level fertilization (factor A)	Hybrids (factor C)					
	Dokuchaevsky 220	Dokuchaevsky 190	Dokuchaevsky 250	Dokuchaevsky 1	SI Phenomenon	SI Rotango
starch						
N <sub>0</sub> P <sub>0</sub> K <sub>0</sub>	61,3	61,9	61,3	61,7	62,0	62,0
N <sub>90</sub> P <sub>90</sub> K <sub>90</sub>	61,6	61,0	62,1	62,6	61,1	61,2
protein						
N <sub>0</sub> P <sub>0</sub> K <sub>0</sub>	7,9	8,9	8,0	7,4	7,4	7,5
N <sub>90</sub> P <sub>90</sub> K <sub>90</sub>	8,4	8,8	8,7	8,1	7,2	7,8

In terms of protein content in grain, domestic hybrids, in General, slightly surpassed foreign counterparts on both unpolished and highly fertilized backgrounds. At the same time, if foreign hybrids practically did not increase the protein content when applying fertilizers, then domestic hybrids provided its increase in grain on average from 8.05 to 8.50%, i.e. by 5.6 %.

#### 4. Conclusion

Thus, the inclusion of an increase in the dose of mineral fertilizer in the technology of corn cultivation for grain has a positive effect on grain productivity. On average, when increasing the doses of fertilizers, a correlation is observed for varieties, when applying doses of fertilizers up to N90P90K90, the yield increases to 1.93 t / ha. In comparison with domestic hybrids of local selection, foreign hybrids of Syngenta proved to be more productive at all levels of fertilization. The yield increase was up to 1.69 t / ha. With a small difference in performance compared to the hybrids of Syngenta, we can note an early-maturing three-line hybrid of local selection Dokuchaevsky 190 recently zoned. The agricultural products studied in the experiment are approximately equivalent in their effectiveness to a dose of mineral fertilizers N30P30K30. The best of them should be considered Lignohumate and Gumi-20M rich, the increase in productivity was 0.48 and 0.89 t / ha, respectively. The greatest impact on the productivity of corn had the use of mineral fertilizers. When increasing the doses of mineral fertilizers, the quality of corn grain is more improved in domestic hybrids.

**Conflict of Interest**

None declared.

**Конфликт интересов**

Не указан.

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