

EFFECT OF GUMILIFE AND BATR ZINC PREPARATIONS ON FORMATION OF HIGH-PRODUCTIVE CORN HYBRID CROPS

© 2026 Mikhailova M. Yu. ✉, Nizamov R. M., Minikaev R. V., Sharafieva I. Z., Faskhutdinov F. Sh.

Kazan State Agrarian University
(Kazan, Russian Federation)
✉ marisha.m.u@mail.ru

Abstract. The study was conducted to assess the effect of Gumilife and Batr zinc on the overall development of corn during the growing season and the formation of green mass yield to improve the crop fertilization system. The work was conducted in 2019-2021 years in Kama region of the Republic of Tatarstan. Experimental scheme: nutrition background (factor A) - without fertilizers, NK at 50 t/ha, NK at 50 t/ha + foliar feeding with Batr zinc, NK at 50 t/ha + seed incrustation with Gumilife, NK at 50 t/ha + seed incrustation with Gumilife + foliar feeding with Batr zinc; hybrid (factor B) - early-ripening Nur and Bilyar-160, mid-early Voronezhskiy-279. Gumilife is an organic biologically active preparation containing humic, carboxylic acids, amino acids, saccharides, carbohydrates. Batr zinc is an organomineral fertilizer saturated with organic acids with a zinc content of 60 g/l. The use of NK combination preparations at a rate of 50 t/ha of green mass increased plant height by 7.7-22.6%, compared to the background without fertilizers, and aboveground mass by 11.8-27.2%, optimizing the ratio of cobs, stems and leaves in the forage. In the green mass of Nur hybrid, this ratio was 45.68:24.89:29.43. Improving the nutritional conditions of corn with the application of mineral fertilizers led to an increase in the yield of green mass of corn by 32-52%. Seed incrustation with Gumilife contributed to the formation of an increase from 2 to 8%, foliar feeding with Batr zinc – from 6 to 8%. The highest yield in the experiment was observed when growing Voronezhskiy-279 hybrid in the NK variant at 50 t/ha + Gumilife incrustation + Batr zinc foliar application – 52.03 t/ha.

Key words: corn (*Zea mays*), micronutrient fertilizer, organic acids, zinc, hybrids, green mass, yield.

For citation: Mikhailova MYu, Nizamov RM, Minikaev RV, et al. [Effect of Gumilife and Batr zinc preparations on formation of high-productive corn hybrid crops]. Vestnik of Kazan State Agrarian University. 2026; Vol. 21. 1(81). 6-13 p. doi: 10.31588/2073-0462-2026-21-1-6-13

ВЛИЯНИЕ ПРЕПАРАТОВ ГУМИЛАЙФ И БАТР ЦИНК НА ФОРМИРОВАНИЕ ГИБРИДОМ КУКУРУЗЫ ВЫСОКОПРОДУКТИВНЫХ ПОСЕВОВ

© 2026 Михайлова М. Ю. ✉, Низамов Р. М., Миникаев Р. В., Шарафиева И. З., Фасхутдинов Ф. Ш.

Казанский государственный аграрный университет
(г. Казань, Российская Федерация)
✉ marisha.m.u@mail.ru

Реферат. Исследования проводили с целью изучения влияния препаратов Гумилайф и Батр цинк на общее развитие кукурузы в течение вегетации и формирование урожая зеленой массы для совершенствования системы удобрения культуры. Работу выполняли в 2019–2021 годы в Предкамье Республики Татарстан. Схема опыта: фон питания (фактор А) – без удобрений, НК на 50 т/га, НК на 50 т/га + листовая подкормка Батр цинк, НК на 50 т/га + инкрустация семян Гумилайф, НК на 50 т/га + инкрустация семян Гумилайф + листовая подкормка Батр цинк; гибрид (фактор В) – раннеспелые Нур и Биляр-160, среднеранний Воронежский-279. Гумилайф – органический биологически активный препарат, содержащий гуминовые, карбоновые кислоты, аминокислоты, сахараиды, углеводы, Батр цинк – органоминеральное удобрение, насыщенное органическими кислотами с содержанием цинка 60 г/л. Использование препаратов на фоне НК в расчете на 50 т/га зеленой массы увеличивало высоту растений, по отношению к фону без удобрений, на 7,7...22,6%, надземную массу – на 11,8...27,2%, оптимизировало соотношение початков, стеблей и листьев в кормах. В зеленой массе гибрида Нур это отношение составляло 45,68:24,89:29,43. Улучшение условий питания кукурузы при внесении минеральных удобрений приводило к увеличению урожайности зеленой массы кукурузы на 32...52%. Инкрустация семян препаратом Гумилайф способствовала формированию прибавки от 2 до 8%, листовая подкормка Батр цинк – от 6 до 8%. Наибольшую в опыте урожайность отмечали при выращивании гибрида Воронежский-279 в варианте НК на 50 т/га + инкрустация Гумилайф + листовая подкормка Батр цинк – 52,03 т/га.

Ключевые слова: кукуруза (*Zea mays*), микроудобрение, органические кислоты, цинк, гибриды, зеленая масса, урожайность.

Для цитирования: Влияние препаратов Гумилайф и Батр цинк на формирование гибридом кукурузы высокопродуктивных посевов / М.Ю. Михайлова, Р.М. Низамов, Р.В. Миникаев и др. // Вестник Казанского государственного аграрного университета. 2026. Т. 21. № 1(81). С. 6-13. doi: 10.31588/2073-0462-2026-21-1-6-13

Introduction. Corn, as a marginal crop, requires a balanced fertilization system to ensure high-yield crop yields, providing the crop with nutrients throughout the growing season [1, 2, 3]. Nutrient requirements are adjusted based on soil availability and the planned yield [4, 5, 6]. Proper hybrid selection allows for high yield increases with the same cultivation technology under different soil and climatic conditions [7]. A wide range of early-maturing hybrids extends the period of possible feeding of green corn as a succulent feed in cattle diets [8, 9].

The use of biological preparations, both for seed treatment and for crop spraying during the growing season, has a beneficial effect on plants [10, 11, 12]. Their use improves the absorption of nutrients from the soil, plants tolerate herbicide treatments better, stress is relieved, and increased yields and quality characteristics of the resulting feed have been noted [13, 14, 15].

Corn responds positively to foliar application of zinc [16]. Zinc is a component of enzymes and is essential for the formation of carbohydrates, proteins, and chlorophyll. Zinc-containing fertilizer applications are divided into two periods. The early period occurs during the 3-6 leaf stage, promoting active chlorophyll accumulation, increasing leaf area, and the formation of above-ground mass. The second period corresponds to the onset of flowering, promoting better cob development [17, 18, 19]. Therefore, the use of bio-preparations and zinc in the nutritional system of corn hybrids is essential for producing highly productive crops.

The aim of the research is to study the effect of the preparations Gumilife and Batr zinc on the general development of corn during the growing season, the formation of the yield of green mass for the improvement of the crop fertilization system.

Conditions, materials, and methods. The study was conducted on gray forest soils of the Middle Volga region in the Laishevsky municipal district of the Republic of Tatarstan from 2019 to 2021. The soil texture of the experimental plot was heavy loamy, with a humus content of 4.2–4.4% according to Tyurin (moderate), mobile phosphorus (very high) according to Kirsanov, over 280 mg/kg, and potassium (high), respectively. The soil pH was neutral (pH_{sol} = 6.1). We sown hybrids included in the State Register, suitable for cultivation in the Middle Volga region: Nur, Bilyar-160, and Voronezhsky-279. The first two hybrids are early-ripening, three-line, general-purpose and silage varieties, with FAO 150 and 160 classifications, respectively. The complex hybrid Voronezhsky-279 is a mid-early, general-purpose variety, with FAO 290 classification. Sowing was carried out when the soil warmed to 10–12°C. The seeding rate was 80,000 seeds/ha.

Experimental design:

Nutrition background (factor A) – no fertilizer, NK at 50 t/ha, NK at 50 t/ha + foliar application of BATR zinc, NK at 50 t/ha + seed incrustation with Gumilife, NK at 50 t/ha + seed incrustation with Gumilife + foliar application of BATR zinc; hybrid (factor B) – Nur, Bilyar-160, Voronezhsky-279.

Fertilizers were applied according to the experimental design at the rate of N157K267 based on the formation of 50 t/ha at the following times: potassium sulfate (534 kg/ha) before sowing under pre-sowing cultivation by broadcasting, nitrogen was applied fractionally - 262 kg/ha of ammonium nitrate (N89) during sowing and 200 kg/ha (N68) in inter-row cultivation in the phase of 5...6 leaves. For weed control, the soil herbicide Merlin 0.15 l/ha was used before the emergence of corn seedlings, and in the phase of 4...5 leaves - the herbicides Ballerina super 0.5 l/ha, Escudo 0.025 kg/ha, Biopower 0.2 l/ha. The accounting of biometric indicators was carried out in the phases of 7...8 leaves, panicleation, milky ripeness. Humilife is a natural, organic, biologically active product containing humic and carboxylic acids, amino acids, saccharides, and carbohydrates. Seeds were treated with Humilife the day before sowing at a rate of 0.5 l/t. Zinc batrate is a liquid organomineral fertilizer saturated with organic acids. The product contains 60 g/l of zinc and 86 g/l of sulfur (calculated as SO₃). Foliar feeding was performed at the 5-6 leaf stage at a rate of 1 l/ha.

Results and discussion. The positive effects of Gumilife and Batr zinc were noted on plant height (Table 1). During the initial stages of development, height varied from 79.3 to 86.3 cm for the Bilyar-160 hybrid; 76.5 to 83.6 cm for the Voronezhsky-279 hybrid; and 76.6 to 91.5 cm for the Nur hybrid. By the panicle stage, the Nur hybrid achieved the highest plant height across all studied variants. By the milky stage, the height of this hybrid's plants was inferior to those of hybrids with a higher FAO value, especially the Voronezhsky-279 hybrid. For the studied products, the combined use of Gumilife and Batr zinc, in combination with mineral fertilizers, outperformed the others. At the head-forming stage, the height of the hybrid plants was 157.5 cm (Bilyar-160), 160.1 cm (Voronezhsky-279), and 164.7 cm (Nur). The plant height increase from these products ranged from 7.0% to 15.0%. Batr zinc increased plant height by 5% to 13%, while treatment with Gumilife increased the height by 4% to 9%. This trend continued during subsequent corn growth. The highest plant heights in the experiment were observed in the variant using the combined treatments: 176.9 cm (Nur), 188.6 cm (Bilyar-160), and 233.9 cm (Voronezhskiy-279). A correlation was found between the hybrid's

FAO value and plant height. From the early stages of development until flowering, hybrids with an FAO of 150 grow and develop faster, but growth slows towards milky ripeness.

Conversely, hybrids with an FAO greater than 200 continue to grow from flowering to milky ripeness, resulting in greater height than early-ripening hybrids.

Table 1 – Plant height (average for 2019–2021), cm

Таблица 1 — Высота растений (в среднем за 2019–2021 годы), см

Nutritional Background (Factor A)	Hybrid (Factor B)	Development Stage		
		7-8 leaves	paniculation	milky ripeness
No fertilizers	Nur	76.6	143.2	152.4
NK at 50 t/ha		87.2	154.5	167.3
NK at 50 t/ha + Batr zinc		88.1	161.9	173.2
NK at 50 t/ha + Gumilife		87.9	156.6	170.4
NK at 50 t/ha + Gumilife + Batr zinc		91.5	164.7	176.9
Average		86.3	156.2	168.0
No fertilizers	Bilyar-160	79.3	147.3	166.6
NK at 50 t/ha		83.2	151.6	173.9
NK at 50 t/ha + Batr zinc		83.7	154.1	178.7
NK at 50 t/ha + Gumilife		83.5	153.6	179.5
NK at 50 t/ha + Gumilife + Batr zinc		86.3	157.5	188.6
Average		83.2	152.8	177.5
No fertilizers	Voronezhsky-279	76.5	143.7	206.3
NK at 50 t/ha		80.8	154.1	212.6
NK at 50 t/ha + Batr zinc		81.3	156.7	217.5
NK at 50 t/ha + Gumilife		81.2	155.3	213.4
NK at 50 t/ha + Gumilife + Batr zinc		83.6	160.1	233.9
Average		80.7	154.0	216.7
No fertilizers	Average	77.5	144.7	175.1
NK at 50 t/ha		83.7	153.4	184.6
NK at 50 t/ha + Batr zinc		84.4	157.6	189.8
NK at 50 t/ha + Gumilife		84.2	155.2	187.8
NK at 50 t/ha + Gumilife + Batr zinc		87.1	160.8	199.8
Average		83.4	154.3	187.4
LSD ₀₅ A		10.6	15.0	22.9
LSD ₀₅ B		23.7	33.5	51.2
LSD ₀₅ AB		28.3	21.9	27.3

Aboveground weight varied significantly across experimental treatments during the milky-wax stage of grain maturity (Table 2). Without fertilizer, it ranged from 26.12 to 42.49 t/ha. Mid-early hybrids also showed an advantage in this indicator. With the application of calculated rates of mineral fertilizer, aboveground weight increased by 3.06 to 5.72 t/ha compared to the unfertilized control, with the greatest increase in early-ripening hybrids. Foliar application of zinc fertilizer resulted in an increase in aboveground mass of 3.5–8.0%, compared to the NK macronutrient application at 50 t/ha. The difference from

the control was 11.0–31.0%. Gumilife treatment increased aboveground mass by 2.04–3.99 t/ha, compared to the control. However, when comparing this treatment with the NK macronutrient application at 50 t/ha, only the Voronezhsky-279 hybrid had a higher aboveground mass, by 0.62 t/ha. On average, the Voronezhsky-279 hybrid demonstrated the highest aboveground mass in the experiment, while in terms of nutritional backgrounds, the treatment with the combined application of the studied preparations was inferior to the NK macronutrient application at 50 t/ha + Batr zinc foliar application by 1.23 t/ha.

Table 2 – Aboveground mass of corn in the milk ripeness phase of grain (average for 2019–2021), t/ha

Таблица 2 – Надземная масса кукурузы в фазе молочной спелости зерна (в среднем за 2019–2021 годы), т/га

Nutritional Background (Factor A)	Hybrid (Factor B)			
	Nur	Bilyar-160	Voronezhsky-279	Average
No fertilizers	26.12	28.42	42.49	32.34
NK at 50 t/ha	31.66	34.14	45.55	37.12
NK at 50 t/ha + Batr zinc	34.22	36.28	47.16	39.22
NK at 50 t/ha + Gumilife	28.16	32.41	46.17	35.58
NK at 50 t/ha + Gumilife + Batr zinc	30.29	36.17	47.50	37.99
Average	30.09	33.48	45.77	
LSD ₀₅ A	4.13			
LSD ₀₅ B	4.58			
LSD ₀₅ AB	9.24			

When growing corn for green fodder, green forage, or silage, it's important to consider the ratio of cobs, stalks, and leaves in the feed. A 45-55% cob/green fodder ratio increases the nutritional value of the feed. Leaves are also rich in carotene. The studied practices influenced these parameters (Table 3). A high proportion of cobs was formed in the variants with foliar feeding with zinc and seed treatment with Gumilife (45.56% – Voronezhskiy-279;

47.51% – Bilyar-160; and 45.58% – Nur). The Nur hybrid in this variant also demonstrated an optimal ratio of stems and leaves in the green mass (24.89 to 29.43%). The Bilyar-160 hybrid was found to be responsive to improved nutritional conditions with an optimal ratio of cobs, stems, and leaves. It amounted to 45.42: 27.10: 27.48. Fertilization had a beneficial effect on the formation and subsequent development of cobs, as well as good foliage of the entire plant.

Table 3 – The share of leaves, stems and cobs in the green mass of corn in the milky-wax ripeness phase of grain (average for 2019–2021), %

Таблица 3 – Доля листьев, стеблей и початков в зелёной массе кукурузы в фазе молочно-восковой спелости зерна (в среднем за 2019–2021 годы), %

Nutritional Background (Factor A)	Hybrid (Factor B)	Plant part		
		cobs	stems	leaves
No fertilizers	Nur	36.63	53.93	9.44
NK at 50 t/ha		41.24	32.11	26.65
NK at 50 t/ha + Batr zinc		43.82	24.88	31.30
NK at 50 t/ha + Gumilife		42.63	26.87	30.50
NK at 50 t/ha + Gumilife + Batr zinc		45.68	24.89	29.43
Average		42.00	32.54	25.46
No fertilizers	Bilyar-160	41.49	21.33	37.18
NK at 50 t/ha		45.71	28.53	25.76
NK at 50 t/ha + Batr zinc		46.36	29.12	24.52
NK at 50 t/ha + Gumilife		46.02	29.00	24.98
NK at 50 t/ha + Gumilife + Batr zinc		47.51	27.54	24.95
Average		45.42	27.10	27.48
No fertilizers	Voronezhsky-279	39.08	33.27	27.64
NK at 50 t/ha		40.25	31.95	27.80
NK at 50 t/ha + Batr zinc		40.93	32.09	26.98
NK at 50 t/ha + Gumilife		41.23	30.29	28.48
NK at 50 t/ha + Gumilife + Batr zinc		45.56	33.02	21.42
Average		41.41	32.12	26.46
No fertilizers	Average	39.07	36.18	24.75
NK at 50 t/ha		42.40	30.86	26.74
NK at 50 t/ha + Batr zinc		43.70	28.70	27.60
NK at 50 t/ha + Gumilife		43.29	28.72	27.99
NK at 50 t/ha + Gumilife + Batr zinc		46.25	28.48	25.27
Average		42.94	30.59	26.47
LSD ₀₅ A		5.29	4.06	3.53
LSD ₀₅ B		11.83	9.07	7.89
LSD ₀₅ AB		27.41	30.22	29.64

Green mass yield at the milky-wax stage of grain maturity varied significantly across the experimental variants (Table 4). In the control, it ranged from 25.63 to 45.81 t/ha. Applying the calculated rates of mineral fertilizers resulted in a yield increase of 10.84 to 13.32 t/ha, with the Nur hybrid showing the greatest response. Foliar application of zinc increased green mass yield in the studied hybrids by 43 to 64%, while seed treatment with Humilife increased yield by 40 to 53%. The highest yield of the sown hybrids was observed in the NK variant at 50 t/ha + Gumilife incrustation + Batr zinc foliar application (45.81; 46.45; 52.03 t/ha). The highest yield increase in the

experiment was also recorded for the Nur hybrid – 20.18 t/ha. The mid-early Voronezhsky-279 hybrid provides higher green forage yields compared to early-maturing hybrids. Each additional measure to improve corn nutritional conditions further increases yield.

On average, applying the calculated rates of mineral fertilizers increases yield by 41%, while additional foliar application of Batr zinc increases yield by 52%, and seed treatment with Humilife increases yield by 46%. Combined application of Humilife and Batr zinc, coupled with improved mineral nutrition, results in a 64% increase compared to the control and a 16% increase compared to the background.

Table 4 – Yield of green mass of corn in the milky-wax ripeness phase of grain (average for 2019-2021), t/ha

Таблица 4 – Урожайность зелёной массы кукурузы в фазе молочно-восковой спелости зерна (в среднем за 2019–2021 годы), т/га

Nutritional Background (Factor A)	Hybrid (Factor B)	Yield, t/ha
No fertilizers	Nur	25.63
NK at 50 t/ha		38.95
NK at 50 t/ha + Batr zinc		42.18
NK at 50 t/ha + Gumilife		39.33
NK at 50 t/ha + Gumilife + Batr zinc		45.81
Average		38.38
No fertilizers	Bilyar-160	28.49
NK at 50 t/ha		40.66
NK at 50 t/ha + Batr zinc		43.42
NK at 50 t/ha + Gumilife		41.37
NK at 50 t/ha + Gumilife + Batr zinc		46.45
Average		40.08
No fertilizers	Voronezhsky-279	33.66
NK at 50 t/ha		44.50
NK at 50 t/ha + Batr zinc		48.16
NK at 50 t/ha + Gumilife		47.35
NK at 50 t/ha + Gumilife + Batr zinc		52.03
Average		45.14
No fertilizers	Average	29.26
NK at 50 t/ha		41.37
NK at 50 t/ha + Batr zinc		44.59
NK at 50 t/ha + Gumilife		42.68
NK at 50 t/ha + Gumilife + Batr zinc		48.10
Average		41.20
LSD ₀₅ A		4.57
LSD ₀₅ B		10.21
LSD ₀₅ AB		24.88

Conclusions. In the Middle Volga region, on gray forest soils in the Republic of Tatarstan, the use of Gumilife for seed encrustations and Batr zinc for foliar application in the 5-6 leaf stage, at a calculated NK background rate of 50 t/ha, resulted in a 10% increase in maize plant height, starting from the 7-8 leaf stage. During the milk stage of grain maturity, this indicator reached its maximum values in the experiment, ranging from 176.9 to 233.9 cm. The mid-season hybrid grows and develops more slowly at the beginning of the growing season and more intensively after flowering than the early-ripening hybrids. Therefore, plant height in the milky stage of maturity increased across the experimental variants in the Nur, Bilyar-160, and Voronezhsky-279 hybrid series, depending on the ripening time (FAO 150 to 290). The increase in aboveground mass with improved nutrient conditions compared to the unfertilized variant was 7–21%, with the use of Gumilife compared to the background level – 1.4%, and with foliar zinc application – 3.5–8.0% compared to the background level. The combined use of mineral fertilizers and the preparations Gumilife and Batr zinc resulted in an increase in

aboveground mass, relative to background levels, of 4.17 to 7.75 t/ha. The mid-early hybrid Voronezhsky-279 achieved the highest green mass yield in the experiment, with the calculated rates of mineral fertilizers and the preparations studied applied, at 52.03 t/ha. Seed incrustation with Humilife before sowing and foliar application of Batr zinc, combined with mineral nutrition designed for a yield of 50 t/ha, contributed to a near-optimal ratio of cobs, stems, and leaves in the harvested forage. The highest response to the studied products was observed in the Nur hybrid. The increase in yield from the application of calculated rates of mineral fertilizers and the use of Humilife and Batr zinc was 20.18 t/ha.

Acknowledgments. The work was supported by a grant from the Academy of Sciences of the Republic of Tatarstan to higher education institutions, research organizations and other organizations to support personnel development plans in terms of encouraging their research and scientific-pedagogical staff to defend doctoral dissertations and conduct research (Agreement dated December 22, 2025 No. 16/2025-PD-KazSAU).

References

1. Efficiency of the biopreparation Biostim on crops of irrigated corn Ross 140 SV / F. N. Safiollin, I. F. Yakhin, M. M. Khismatullin, et al. // Vestnik of Kazan State Agrarian University. 2024. Vol. 19. No. 3 (75). Pp. 33–39. doi: 10.12737/2073-0462-2024-33-39.
2. Safin R. I., Ziganshin A. A. Effect of the use of liquid organomineral fertilizers on the yield and quality of green mass of corn // Vestnik of Kazan State Agrarian University. 2025. Vol. 20. No. 3 (79). Pp. 39–44. doi: 10.12737/2073-0462-2025-20-3-39-44.
3. Mikhailova M. Yu., Talanov I. P. Nutritional value of corn hybrids when grown for green mass // Agrarian science. 2016. No. 4. pp. 9–11.
4. Sabirova R. M., Shakirov R. S., Bismukhametov Z. M. Bioplant Flora – a new generation fertilizer // Vestnik of Kazan State Agrarian University. 2019. Vol. 14. No. 2 (53). Pp. 37–42. doi: 10.12737/article_5d3e15f17c3223.64554857.
5. Mikhailova M. Yu., Minikaev R. V. Dynamics of macroelements in gray forest soil under corn crops for green mass in the conditions of the Volga region of the Republic of Tatarstan with the application of increased doses of mineral fertilizers // Plodorodie. 2020. No. 3 (114). Pp. doi: 10.25680/S19948603.2020.114.03.
6. Forecasting the yield of spring wheat by agrochemical properties in the conditions of the Tetyushsky region of the Republic of Tatarstan / A. A. Lukmanov, Yu. P. Perevedentsev, A. B. Mustafina, etc. // Vestnik of Kazan State Agrarian University. 2023. T. 18. No. 3 (71). pp. 39–45. doi: 10.12737/2073-0462-2023-39-45.
7. Productivity of corn Ross 140 depending on the level of chemicalization of zonal soils of the Republic of Tatarstan / F. N. Safiollin, M. M. Khismatullin, A. A. Lukmanov, etc. // Bulletin of the Soil Institute named after. V.V. Dokuchaeva. 2023. No. 115. pp. 199–223. doi: 10.19047/0136-1694-2023-115-199-223.
8. Mukhamadiev R. Kh., Nizamov R. M., Malikov M. M. Feed mixtures in the forage production system of the Republic of Tatarstan // Vestnik of Kazan State Agrarian University. 2017. Vol. 12. No. 4 (46). Pp. 20–22. doi: 10.12737/article_5a5f049c9a5b93.89385750.
9. Talanov I. P., Mikhailova M. Yu., Karimova L. Z. Responsiveness of corn hybrids to the application of calculated doses of mineral fertilizers in the conditions of the Cis-Volga region of the Republic of Tatarstan // Vestnik of Kazan State Agrarian University. 2015. Vol. 10. No. 2 (36). Pp. 123–127. doi: 10.12737/12516.
10. Productivity of agricultural crops with the use of biopreparations based on rhizosphere bacteria (PGPR) / L. Z. Karimova, L. S. Nizhegorodtseva, V. A. Kolesar, et al. // Vestnik of Kazan State Agrarian University. 2019. Vol. 14. No. S4-1(55). – P. 52–58.
11. The effect of foliar feeding on the formation of generative organs in corn / M. Yu. Mikhailova, R. V. Minikaev, M. F. Amirov, et al. // Vestnik of Kazan State Agrarian University. 2024. Vol. 19. No. 1 (73). P. 12–17. doi: 10.12737/2073-0462-2024-12-17.
12. Eryashev A. P., Artemyev A. A., Khnykin T. V. Effect of fertilizers and growth regulator on corn grain yield // Vestnik of Ulyanovsk State Agricultural Academy. 2025. No. 3 (71). pp. 6–12. doi: 10.18286/1816-4501-2025-3-6-12.
13. Economic indicators of the biological system for protecting sunflower from head rot in the soil and climatic conditions of the Republic of Tatarstan / F. N. Safiollin, M. M. Khismatullin, G. S. Minnullin, et al. // Vestnik of Kazan State Agrarian University. 2023. Vol. 18. No. 1 (69). Pp. 147–154. doi: 10.12737/2073-0462-2023-147-154.
14. The influence of primary tillage methods and fertilizers on the dynamics of soil moisture, water consumption, and yield of corn when grown for silage / V. N. Fomin, M. M. Nafikov, V. V. Medvedev, et al. // Achievements of science and technology in the agro-industrial complex. 2017. T. 31. No. 12. P. 12–16.
15. Ziganshin A. A., Safin R. I. Features of grain corn yield formation using foliar feeding with organomineral fertilizers // Agrobiotechnology and digital farming. 2024. No. 3 (11). Pp. 28–33. doi: 10.12737/2782-490X-2024-28-33.
16. The influence of fertilizers on corn yield in Stavropol Krai / V. N. Bagrintseva, I. N. Ivashenko, V. V. Dridiger, et al. // Achievements of science and technology in the agro-industrial complex. 2023. Vol. 37. No. 7. Pp. 29–33. doi: 10.53859/02352451_2023_37_7_29.
17. The Impact of Chemicalization on the Formation of the Yield of Green Mass of Corn with Cobs of Milky-Wax Ripeness / I. F. Yakhin, R. Kh. Gabitov, M. M. Khismatullin, et al. // Agrobiotechnology and Digital Farming. 2023. No. 2 (6). Pp. 44–51. doi: 10.12737/2782-490X-2023-44-51.
18. Nafikov M. M., Khafizova A. R. Cultivation of Forage Crops in Single-Species and Mixed Crops in the Western Trans-Kama Region of the Republic of Tatarstan // Vestnik of Kazan State Agrarian University. 2010. Vol. 5. No. 2 (16). Pp. 138–142.
19. Chemical composition of feed depending on the methods of primary tillage and nutritional backgrounds / V. V. Medvedev, V. N. Fomin, M. M. Nafikov et al. // Vestnik of Kazan State Agrarian University. 2020. Vol. 15. No. 1 (57). P. 32–37. doi: 10.12737/2073-0462-2020-32-37.

Литература

1. Эффективность биопрепарата Биостим на посевах орошаемой кукурузы Росс 140 СВ / Ф. Н. Сафиоллин, И. Ф. Яхин, М. М. Хисматуллин и др. // Вестник Казанского государственного аграрного университета. 2024. Т. 19. № 3 (75). С. 33–39. doi: 10.12737/2073-0462-2024-33-39.
2. Сафин Р. И., Зиганшин А. А. Влияние применения жидких органоминеральных удобрений на урожайность и качество зеленой массы кукурузы // Вестник Казанского государственного аграрного университета. 2025. Т. 20. № 3 (79). С. 39–44. doi: 10.12737/2073-0462-2025-20-3-39-44.
3. Михайлова М. Ю., Таланов И. П. Питательная ценность гибридов кукурузы при возделывании на зеленую массу // Аграрная наука. 2016. № 4. С. 9–11.
4. Сабирова Р. М., Шакиров Р. С., Бикмухаметов З. М. Биоплант Флора – удобрение нового поколения // Вестник Казанского государственного аграрного университета. 2019. Т. 14. № 2 (53). С. 37–42. doi: 10.12737/article_5d3e15f17c3223.64554857.
5. Михайлова М. Ю., Миникаев Р. В. Динамика макроэлементов в серой лесной почве под посевами кукурузы на зеленую массу в условиях Предволжья Республики Татарстан при внесении повышенных доз минеральных удобрений // Плодородие. 2020. № 3 (114). С. 12–14. doi: 10.25680/S19948603.2020.114.03.

6. Прогнозирование урожайности яровой пшеницы по агрохимическим свойствам в условиях Тетюшского района Республики Татарстан / А. А. Лукманов, Ю. П. Переведенцев, А. Б. Мустафина и др. // Вестник Казанского государственного аграрного университета. 2023. Т. 18. № 3 (71). С. 39–45. doi: 10.12737/2073-0462-2023-39-45.
7. Продуктивность кукурузы Росс 140 в зависимости от уровня химизации зональных почв республики Татарстан / Ф. Н. Сафиоллин, М. М. Хисматуллин, А. А. Лукманов и др. // Бюллетень Почвенного института им. В. В. Докучаева. 2023. № 115. С. 199–223. doi: 10.19047/0136-1694-2023-115-199-223.
8. Мухамадиев Р. Х., Низамов Р. М., Маликов М. М. Кормосмеси в системе кормопроизводства Республики Татарстан // Вестник Казанского государственного аграрного университета. 2017. Т. 12. № 4 (46). С. 20–22. doi: 10.12737/article_5a5f049c9a5b93.89385750.
9. Таланов И. П., Михайлова М. Ю., Каримова Л. З. Отзывчивость гибридов кукурузы на внесения расчетных доз минеральных удобрений в условиях Предволжья РТ // Вестник Казанского государственного аграрного университета. 2015. Т. 10. № 2 (36). С. 123–127. doi: 10.12737/12516.
10. Продуктивность сельскохозяйственных культур при применении биопрепаратов на основе ризосферных бактерий (PGPR) / Л. З. Каримова, Л. С. Нижегородцева, В. А. Колесар и др. // Вестник Казанского государственного аграрного университета. 2019. Т. 14. № S4-1(55). – С. 52–58.
11. Влияние некорневых подкормок на формирование генеративных органов у кукурузы / М. Ю. Михайлова, Р. В. Миникаев, М. Ф. Амиров и др. // Вестник Казанского государственного аграрного университета. 2024. Т. 19. № 1 (73). С. 12–17. doi: 10.12737/2073-0462-2024-12-17.
12. Еряшев А. П., Артемьев А. А., Хныкин Т. В. Влияние удобрений и регулятора роста на урожайность зерна кукурузы // Вестник Ульяновской государственной сельскохозяйственной академии. 2025. № 3(71). С. 6–12. doi: 10.18286/1816-4501-2025-3-6-12.
13. Экономические показатели биологической системы защиты подсолнечника от корзиночных гнилей в почвенно-климатических условиях Республики Татарстан / Ф. Н. Сафиоллин, М. М. Хисматуллин, Г. С. Миннуллин и др. // Вестник Казанского государственного аграрного университета. 2023. Т. 18. № 1 (69). С. 147–154. doi: 10.12737/2073-0462-2023-147-154.
14. Влияние способов основной обработки почвы и удобрений на динамику влажности почвы, водопотребление и урожайность кукурузы при выращивании на силос / В. Н. Фомин, М. М. Нафиков, В. В. Медведев и др. // Достижения науки и техники АПК. 2017. Т. 31. № 12. С. 12–16.
15. Зиганшин А. А., Сафин Р. И. Особенности формирования урожая кукурузы на зерно при использовании некорневой подкормки органоминеральными удобрениями // Агробиотехнологии и цифровое земледелие. 2024. № 3 (11). С. 28–33. doi: 10.12737/2782-490X-2024-28-33.
16. Влияние удобрений на урожайность кукурузы в Ставропольском крае / В. Н. Багринцева, И. Н. Ивашененко, В. В. Дридингер и др. // Достижения науки и техники АПК. 2023. Т. 37. № 7. С. 29–33. doi: 10.53859/02352451_2023_37_7_29.
17. Влияние средств химизации на формирование урожая зеленой массы кукурузы с початками молочно-восковой спелости / И. Ф. Яхин, Р. Х. Габитов, М. М. Хисматуллин и др. // Агробиотехнологии и цифровое земледелие. 2023. № 2 (6). С. 44–51. doi: 10.12737/2782-490X-2023-44-51.
18. Нафиков М. М., Хафизова А. Р. Возделывание кормовых культур в одновидовых и смешанных посевах в Западном Закамье РТ // Вестник Казанского государственного аграрного университета. 2010. Т. 5. № 2 (16). С. 138–142.
19. Химический состав кормов в зависимости от способов основной обработки почвы и фонов питания / В. В. Медведев, В. Н. Фомин, М. М. Нафиков и др. // Вестник Казанского государственного аграрного университета. 2020. Т. 15. № 1 (57). С. 32–37. doi: 10.12737/2073-0462-2020-32-37.

Conflict of interest. The authors declare no conflict of interest.

Authors:

Mikhailova Marina Yurievna – Ph.D. of Agricultural Sciences, Associate Professor of Agrochemistry and Soil Science Department Kazan State Agrarian University (65 Karl Marx Street, Kazan, 420015, Russian Federation), e-mail: marisha.m.u@mail.ru, ORCID 0000-0002-0894-9275

Nizamov Rustam Mingazovich – Doctor of Agricultural Sciences, Professor of General Agriculture, Plant Protection and Breeding Department Kazan State Agrarian University (65 Karl Marx Street, Kazan, 420015, Russian Federation), e-mail: nizamovr@mail.ru, ORCID 0000-0002-5436-9351

Minikaev Rogat Vagizovich – Doctor of Agricultural Sciences, Head of Agrochemistry and Soil Science Department Kazan State Agrarian University (65 Karl Marx Street, Kazan, 420015, Russian Federation), e-mail: ragat@mail.ru, ORCID 0000-0002-0860-2642

Sharafieva Ilyusa Zulfatovna – post-graduate student of Agrochemistry and Soil Science Department Kazan State Agrarian University (65 Karl Marx Street, Kazan, 420015, Russian Federation), e-mail: kurbangalieva_1999@mail.ru

Faskhutdinov Fannur Shaukatovich – Ph.D. of Agricultural Sciences, Associate Professor of Agrochemistry and Soil Science Department Kazan State Agrarian University (65 Karl Marx Street, Kazan, 420015, Russian Federation), e-mail: ditto1961t@mail.ru, ORCID 0000-0002-0860-2642

Contribution of the authors:

M.Y. Mikhailova – Supervision, Conceptualization, Validation, Investigation, Writing — Original Draft, Writing — Review & Editing, Visualization;

R.M. Nizamov – Supervision;

R.V. Minikaev – Validation;

I.Z. Sharafieva – Investigation;

F.Sh. Faskhutdinov – Formal Analysis.

The authors have reviewed and approved the final manuscript.

Submitted 04.05.2025; revised 31.03.2026; accepted 01.04.2026.

Конфликт интересов. Авторы заявляют об отсутствии конфликта интересов.

Сведения об авторах:

Михайлова Марина Юрьевна – кандидат сельскохозяйственных наук, доцент кафедры агрохимии и почвоведения Казанского государственного аграрного университета (420015, Российская Федерация, г. Казань, ул. Карла Маркса, 65), e-mail: marisha.m.u@mail.ru, ORCID 0000-0002-0894-9275

Низамов Рустам Мингазизович – доктор сельскохозяйственных наук, профессор кафедры общего земледелия, защиты растений и селекции Казанского государственного аграрного университета (420015, Российская Федерация, г. Казань, ул. Карла Маркса, 65), e-mail: nizamovr@mail.ru, ORCID 0000-0002-5436-9351

Минникаев Рогать Вагизович – доктор сельскохозяйственных наук, зав. кафедрой агрохимии и почвоведения Казанского государственного аграрного университета (420015, Российская Федерация, г. Казань, ул. Карла Маркса, 65), e-mail: ragat@mail.ru, ORCID 0000-0002-0860-2642

Шарафиева Илюса Зульфатовна – аспирант кафедры агрохимии и почвоведения Казанского государственного аграрного университета (420015, Российская Федерация, г. Казань, ул. Карла Маркса, 65), e-mail: kurbangalieva_1999@mail.ru

Фасхутдинов Фаннур Шаукатович – кандидат сельскохозяйственных наук, доцент кафедры агрохимии и почвоведения Казанского государственного аграрного университета (420015, Российская Федерация, г. Казань, ул. Карла Маркса, 65), e-mail: ditto1961t@mail.ru, ORCID 0000-0002-0860-2642

Вклад авторов:

М.Ю. Михайлова – научное руководство, концептуализация, валидация, проведение исследования, подготовка оригинального текста, рецензирование и редактирование текста, визуализация.

Р.М. Низамов – научное руководство;

Р.В. Минникаев – валидация;

И.З. Шарафиева – проведение исследования;

Ф.Ш. Фасхутдинов – формальный анализ.

Все авторы ознакомились и одобрили окончательный вариант рукописи.

Поступила 04.05.2025; одобрена после рецензирования 31.03.2026; принята к публикации 01.04.2026.

