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# INFLUENCE OF THE FERTILIZATION SYSTEM ON PRODUCTIVE INDICATORS OF WINTER WHEAT

A rational fertilization system determines both quantitative and qualitative yield parameters by supplying plants with necessary nutrients at different development stages. Inappropriate rates, timing, or fertilizer forms reduce nutrient use efficiency, lead to soil fertility degradation, increased nitrate losses and greenhouse gas emissions, and cause economic losses for producers.

Field trials were conducted from 2023 to 2025 on the premises of the agricultural enterprise SFG «Druzhba». Two winter wheat cultivars were used in the study: Karmeliuk and Lira Odeska.

Fertilization variants:

1. Control.
2. $N_{90}P_{60}K_{60}$
3. $N_{60}P_{60}K_{60}$ + $N_{30}$ (III organogenesis stage)
4. $N_{45}P_{60}K_{60}$ + $N_{30}$ (III organogenesis stage) + $N_{15}$ (VIII organogenesis stage)

The number of productive stems and spikelets formed is the determining factor for the number of kernels and, consequently, final yield. Therefore, modern agronomic technologies aim to stimulate the number of productive stems and the formation of a large number of high-quality kernels per spike to maximize winter wheat yield. Considering these structural components and their interactions, agronomists can more accurately predict yield and adjust cropping technologies to achieve high performance.

In our 2025 studies, for the Karmeliuk cultivar the plant density in the control (no fertilizers) was 312 plants $m^2$. Application of fertilizers at the $N_{90}P_{60}K_{60}$ rate resulted in a slight increase to 314 plants $m^2$. Under $N_{60}P_{60}K_{60}$ + $N_{30}$ the density was 310 plants $m^2$. The lowest density, 308 plants $m^2$, occurred with $N_{45}P_{60}K_{60}$ + $N_{30}$ + $N_{15}$.

Productive stem number for Karmeliuk in 2025 ranged from 356 to 580 stems $m^2$: the minimum was in the unfertilized control. Fertilization with $N_{90}P_{60}K_{60}$ produced a notable increase to 506 stems $m^2$. The maximum number of productive stems was recorded under $N_{45}P_{60}K_{60}$ + $N_{30}$ + $N_{15}$ – 580 stems $m^2$, and under $N_{60}P_{60}K_{60}$ + $N_{30}$ – 571 stems $m^2$.

Plant height in 2025 varied from 77,4 to 94,2 cm. The shortest plants were in the control $N_{90}P_{60}K_{60}$ raised height to 90,4 cm, and $N_{60}P_{60}K_{60}$ + $N_{30}$ to 92,6 cm. The tallest plants (94,2 cm) were observed with $N_{45}P_{60}K_{60}$ + $N_{30}$ + $N_{15}$.

The fertilization system also affected spike length. In the control spike length was 5,2 cm. It increased to 6,4 cm with $N_{90}P_{60}K_{60}$, to 6,6 cm with $N_{60}P_{60}K_{60}$ + $N_{30}$, and to 6,7 cm with $N_{45}P_{60}K_{60}$ + $N_{30}$ + $N_{15}$.

The number of kernels per spike also depended on fertilization. The highest numbers – 25,8 and 25,6 kernels – were obtained in the $N_{60}P_{60}K_{60}$ + $N_{30}$ and $N_{45}P_{60}K_{60}$ + $N_{30}$ + $N_{15}$ variants, respectively. In the control the number was 20,6 kernels, and with $N_{90}P_{60}K_{60}$ – 24,1 kernels.

In 2025, for the Lira Odeska cultivar the plant density in the control (no fertilizers) was 314 plants m². Application of $N_{90}P_{60}K_{60}$ reduced this to 3123 plants m². Under $N_{60}P_{60}K_{60}$ + $N_{30}$ density increased to 316 plants m². The highest density – 318 plants m² – was observed with $N_{45}P_{60}K_{60}$ + $N_{30}$ + $N_{15}$.

Productive stem number for Lira Odeska in 2025 ranged from 383 to 600 stems m². The minimum was in the unfertilized control. $N_{90}P_{60}K_{60}$ produced a significant increase to 566 stems m². The maximum – 600 stems m² – was achieved with $N_{60}P_{60}K_{60}$ + $N_{30}$ and also with $N_{45}P_{60}K_{60}$ + $N_{30}$ + $N_{15}$, which provided 594 and 600 stems, respectively.

Plant height in 2025 ranged from 80,3 to 95,1 cm. The shortest plants were in the control $N_{90}$P60K60 increased height to 93,2 cm, and $N_{60}P_{60}K_{60}$ + $N_{30}$ to 94,0 cm. The tallest plants (95,0 cm) formed with $N_{45}P_{60}K_{60}$ + $N_{30}$ + $N_{15}$.

Fertilization also influenced spike length. In the control spike length was 6,0 cm. $N_{90}P_{60}K_{60}$ increased it to 6,7 cm, $N_{60}P_{60}K_{60}$ + $N_{30}$ to 7,1 cm and $N_{45}P_{60}K_{60}$ + $N_{30}$ + $N_{15}$ to 7,1 cm.

The number of kernels per spike likewise depended on fertilization. The highest counts – 28,5 and 29,8 kernels – were recorded for $N_{60}P_{60}K_{60}$ + $N_{30}$ and $N_{45}P_{60}K_{60}$ + $N_{30}$ + $N_{15}$, respectively. In the control the number was 22,0 kernels, and with $N_{90}P_{60}K_{60}$ – 27,3 kernels.

Yield is the primary indicator for evaluating the effectiveness of any cultivation technology, as it most comprehensively characterizes the influence of agronomic elements on yield structural components. Analysis of the studies confirms that application of different mineral fertilization variants has a significant effect on winter wheat yield. The maximum yield for the Karmeliuk cultivar – 6.36 t/ha, was obtained with the complex fertilizer regime $N_{30}P_{60}K_{60}$ + $N_{30}$ (III organogenesis stage) and $N_{15}$ (VIII organogenesis stage). The lowest mean yield across years was in the unfertilized control – 3,14 t /ha. Application of mineral fertilizers at $N_{90}P_{60}K_{60}$ increased yield to 5,47 t/ha, while the $N_{30}P_{60}K_{60}$ + $N_{30}$ regime indicated the most effective way to improve performance.

The highest yield for Lira Odeska – 7,00 t/ha, was obtained with the complex mineral fertilization regime $N_{30}P_{60}K_{60}$ + $N_{30}$ (III organogenesis stage) and $N_{15}$ (VIII organogenesis stage). The maximum mean annual yield was recorded under this regime. The lowest yield – 3,53 t/ha – was in the control. Application of $N_{90}P_{60}K_{60}$ increased yield to 5,50 t/ha and $N_{30}P_{60}K_{60}$ + $N_{30}$ (III stage) produced 6,48 t/ha.