

# Effect of late nitrogen nutrition on formation of harvest elements, grain yield, and quality indicators of winter wheat

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**Abstract.** It is known that almost 50% of winter wheat harvest is due to mineral fertilizers. Among mineral fertilizers, nitrogenous fertilizers are of special importance. The plant's response to nitrogen fertilizers starts from the initial stages of plant development and continues until the ripening stage. Nitrogen is involved in all physiological processes in the plant. Nitrogen fertilizers differ from other types of macro fertilizers in their mobility. These fertilizers have a quick effect on the plant and are easily absorbed by the plant. There are different opinions about winter wheat fertilization. Some experts believe that the annual rate of nitrogen fertilizers should be applied in the early stages of development, in early spring. Other authors state that nitrogen fertilization is necessary two or three times during the season. In the experiment, a relatively low indicator of grain yield was observed in the control option of 35 q/ha, and the highest indicator was 72 q/ha in the triple-fed option. In the experiment, additional nitrogen fertilization provided an additional grain yield of 21-37 q/ha of winter wheat. The highest results for all quality indicators of grain were recorded in conditions where nitrogen fertilizer was applied at the rate of 80+80+40 kg/ha three times during the growing season. In this variant, the grain transparency was 90%, the protein content was 14.3%, and the gluten content was 30.3%.

## 1 Introduction

In most countries, including Uzbekistan, the body's need for protein is mainly met at the expense of bread products [1-4]. The amount of protein in the grain is important for making good bread. There is a direct correlation between protein content and gluten content. In strong wheat varieties, the level of positive correlation for protein and gluten content of grain is equal to 0.9 [5-9].

The main reason for the reduction of protein and gluten in grain is the lack of nitrogen in the soil that can be absorbed by plants as the grain yield of winter wheat varieties increases. First of all, it depends on the plant's absorption of nitrogen [10-13]. For example, if the absorption of phosphorus and potassium fertilizers by the plant continues until flowering, the absorption of nitrogen continues even after flowering [14].

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Wheat requires about 20-30% of its nitrogen requirement during grain formation and filling. But in many cases, there is a lack of nitrogen in the soil during this period, especially when a high yield is formed, and it leads to a decrease in grain quality. In order to maintain the grain yield and its quality, it is necessary to fully satisfy the plant's need for nitrogen fertilizers during the season [15, 16].

The positive effect of mineral fertilizers, especially nitrogen fertilizers, on the technological quality indicators of grain in foreign countries Remeslo [7], Lukyanenko [5], and Malyuga [6] and in different soil and climate conditions of Uzbekistan Amanov [1], Atabaeva [2], Sidikov [8], Khalilov [11], and Azizov [3, 4] were studied in their research.

Also, the importance of wheat in foreign countries, cultivation technology has been studied in the scientific works of scientists such as Yigezu et al. [12], Llewellyn et al. [13, 14], and Chauhan [15].

Remeslo [7] and Lukyanenko [5] focused on improving the quality of the variety in improving grain quality. According to Malyuga [6], grain quality depends to some extent on soil fertility. Amanov [1] and Sidikov [8] emphasize that the correct organization of the selection and seed breeding system is of great importance in improving grain quality. Khalilov [11] and Atabaeva [2] stated that the quality of wheat grain depends to some extent on agrotechnical factors. According to Azizov [3, 4], wheat grain quality depends to some extent on late nitrogen fertilization.

There are different opinions about winter wheat fertilization. Some experts believe that the annual rate of nitrogen fertilizers should be applied in the early stages of development, in early spring. Other authors state that nitrogen fertilization is necessary two or three times during the season. Early spring nitrogen fertilization has a positive effect on the nutrient regime of the soil. This condition is explained by the good absorption of nitrogen by the vegetative organs of the plant.

As can be seen from the above, there is no single opinion on the number of nitrogen fertilization of winter wheat. Because of this, we conducted scientific research on the influence of winter wheat late nitrogen fertilization on grain quality.

## 2 Materials and methods

The experiments were conducted in the fields of the educational experimental station of Tashkent State Agrarian University, Uzbekistan. The soil of the experimental field is a typical gray loam that has been irrigated for a long time. In the experiment, winter wheat varieties were planted in four different mineral environments. The area of each option is 200 m<sup>2</sup>, of which the calculated area is 100 m<sup>2</sup>, and the protected area is 100 m<sup>2</sup>. Each variant consists of eight wide rows of furrows, of which the four furrows in the middle are considered areas, and the furrows two to four on both sides are protective furrows.

Placement of options and returns in the experiment and phenological observations and calculations are carried out according to Dospekhov [3, 4]. Phenological observations are carried out in the first days of March, April, May and June on 50 plants separated by special tags of each variant.

In the experiment, grain gloss was determined on special DZS-2 apparatus according to GOST 10987-76. The amount of protein in grain was determined by the K'eldel method. The amount of gluten in the cereal was determined according to GOST 13586-68. In the experiment, the quality of gluten was determined on IDK-1, PEK-3A devices.

### 3 Results and discussion

The growth of winter wheat and the formation of crop elements depend to a certain extent on mineral fertilization, including nitrogen fertilization of the plant. Nitrogen efficiency is observed from the early stages of winter wheat development.

Winter wheat needs mineral nutrients throughout the growing season, including nitrogen fertilizers, and this need continues until the end of the growing season. Nitrogen fertilization also had a positive effect on the formation of yield elements in winter wheat. Experimental data on the formation of yield elements in winter wheat are presented in Table 1.

**Table 1.** Formation of crop elements of winter wheat.

Options	Productivity	Weight of 1000 grains, g	In a pod		
			Number of grains	Pod-grain weight, g	Plant-grain weight, g
PK (Control)	1.1	35	26	0.9	0.99
PK + N200 in sprouting	1.3	38	32	1.2	1.56
PK + N100 in sprouting + N100 in branching	1.4	39	36	1.4	1.96
PK + N80 in sprouting + N80 in branching + N40 in podding	1.4	40	38	1.5	2.1

In the experiment, in the options where nitrogen fertilizers were used, superiority over the control option was observed in all parameters of the crop elements. The productive yield of winter wheat was 1.1 in the control option, while it was 1.3-1.4 in the options where nitrogen fertilizers were applied.

The lowest value of 1000 grain weight of winter wheat was 35 grams in the RK mineral background, the highest value was 40 grams in the option with 3 times nitrogen fertilization. This indicator is 2 grams higher than the option with nitrogen fertilizers for the 1st time, and 5 grams higher than the control option. When winter wheat was fed with nitrogen fertilizers 3 times during the growing season, the number of grains in the pod was 12 more than the control, and 2-6 more than the other options.

The weight of grain in one pod was equal to 0.9 grams in the control option, 1.2 grams when nitrogen fertilizers were applied once, 1.4 grams when applied twice, and 1.5 grams when applied three times. Due to additional nitrogen fertilization, the grain weight in one pod increased from 0.1 to 0.6 grams. Also, additional nitrogen fertilization increased the weight of grain in one plant by 0.15-1.14 grams.

Nitrogen fertilization of winter wheat leads to the formation of the leaf surface at a mature level in the plant and acceleration of the photosynthesis process. This condition, in turn, ensures an increase in biological productivity. Late nitrogen fertilization had a positive effect on the formation of biological yield in grain. The results of the experiment on the formation of biological crops in winter wheat are presented in Table 2.

In the experiment, in the control option where nitrogen fertilizers were not applied, grain yield was 35.0 q/ha, straw yield was 52.5 q/ha, root mass yield was 36.5 q/ha, and total biological yield was 124.0 q/ha. In the control option, the ratio of grain and straw yield was equal to 1:1.5.

The total biological yield was 191.4 q/ha, of which 56.0 q/ha was grain yield in the conditions where the annual rate of mineral fertilizers was applied once in fertilization. The ratio of grain and straw yield was equal to 1:1.4.

**Table 2.** Biological productivity of winter wheat.

Options	Biological productivity, g/m <sup>2</sup> per day				Biological yield, q/ha	Grain and straw ratio
	Root	Straw	Grain	Total		
PK (Control)	365	525	350	1240	124.0	1:1.5
PK + N200 in sprouting	570	784	560	1914	191.4	1:1.4
PK + N100 in sprouting + N100 in branching	660	871	670	2201	220.1	1:1.3
PK + N80 in sprouting + N80 in branching + N40 in podding	670	864	720	2254	225.4	1:1.2

The total biological yield of winter wheat was 220.1 q/ha, of which 67.0 q/ha was the grain yield in the nitrogen-fed option in two times: heading and tuber phases. In the experiment, the highest indicator of total biological yield of 225.4 q/ha was observed in the option fed with nitrogen three times during the season. In this option, the total biological yield was 101.4 q/ha higher than the control, and 5.3 - 34.0 q/ha higher than the other options.

Undoubtedly, the most important indicator in the cultivation of winter wheat is grain yield. Mineral fertilization is undoubtedly one of the important factors for increasing grain yield. Including, it is considered to fully satisfy the plant's need for nitrogen during the season. Information on the effect of additional nitrogen fertilization on grain yield is presented in Table 3.

**Table 3.** Effect of additional nitrogen fertilization on grain yield.

Options	Grain yield according to iterations, q/ha				Average grain yield, q/ha	Additional grain yield, q/ha
	I	II	III	IV		
PK (Control)	33	36	37	34	35	-
PK + N200 in sprouting	53	57	56	58	56	21
PK + N100 in sprouting + N100 in branching	64	69	68	67	67	32
PK + N80 in sprouting + N80 in branching + N40 in podding	70	73	71	74	72	37

As can be seen from the data presented above, in the experiment, a relatively low indicator of grain yield was observed in the control option of 35 q/ha, and the highest indicator was 72 q/ha in the triple-fed option.

In the experiment, additional nitrogen fertilization provided an additional grain yield of 21-37 q/ha of winter wheat. Therefore, in the irrigated fields of the Tashkent region of Uzbekistan, it is advisable to feed winter wheat with nitrogen three times during the season: during the heading, tuber and flowering phases.

Improving the quality of winter wheat grain is one of the most urgent problems today. It is very difficult to maintain and increase grain quality, especially under irrigated conditions. Because grain yield and technological quality indicators of grain have an inverse correlation. That is, as grain yield increases, grain quality decreases. The main reason for this is that during the formation of grains, the amount of nitrogen absorbed by the plant in the soil is insufficient.

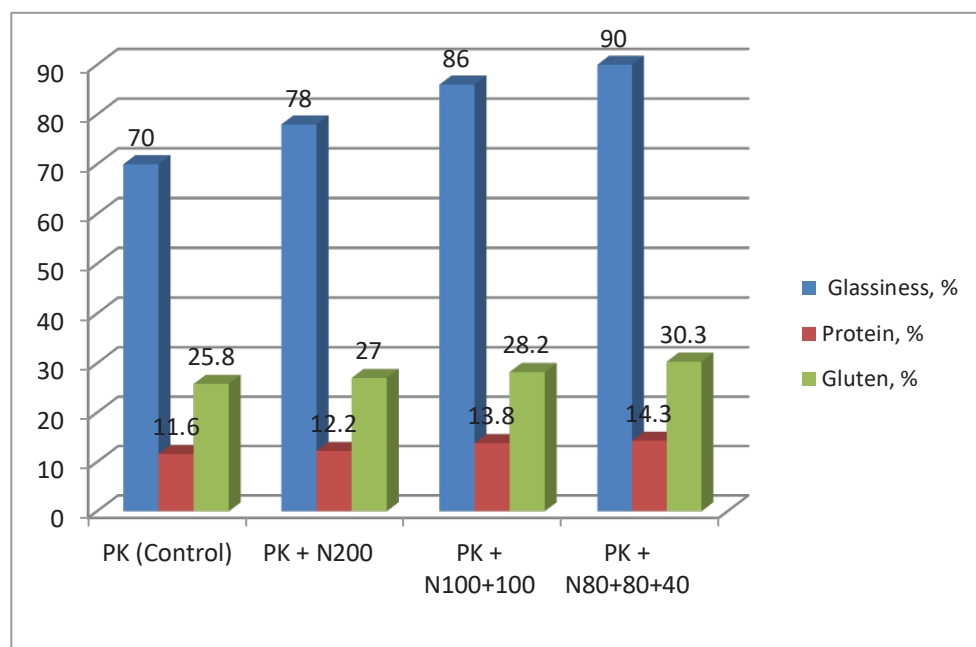
In order to satisfy the plant's need for nitrogen during the entire vegetation period, it is advisable to fertilize with nitrogen three times during the season. In this case, a part of nitrogen fertilizers is used in the podding-flowering phase of winter wheat.

In order to prevent nitrogen deficiency during the formation of grains in winter wheat, it is necessary to carry out additional nitrogen fertilization during the cultivation of winter wheat. The effect of additional nitrogen fertilization on grain quality is presented in Table 4 and Figure 1.

**Table 4.** Technological quality indicators of grain.

Options	Glassiness of grain, %	In the content of grain, %		Grain volume, cm3	Grain quality
		Protein	Gluten		
PK (Control)	70	11.6	25.8	405	Medium
PK + N200 in sprouting	78	12.2	27.0	480	Medium
PK + N100 in sprouting + N100 in branching	86	13.8	28.2	600	High
PK + N80 in sprouting + N80 in branching + N40 in podding	90	14.3	30.3	690	High

In the experiment, the highest values for all technological indicators of grain were observed in the option fed with additional nitrogen in the phase of winter wheat podding. In this option, the amount of protein in the grain was 14.3%, gluten was 30.3%. The quality of the grain was at the level of the requirements of the strong wheat pattern. Due to additional nitrogen fertilization, grain vitreousness increased by 4-20%, protein content by 0.5-1.7%, and gluten content by 2.1-4.5%.



**Figure 1.** Effect of late nitrogen fertilization on grain quality.

As can be seen from the figure above, the highest results for all quality indicators of grain were recorded in conditions where nitrogen fertilizer was applied at the rate of 80+80+40 kg/ha three times during the growing season. In this option, grain transparency was 90%, protein content was 14.3%, and gluten content was 30.3%.

## 4 Conclusions

Due to additional nitrogen fertilization, the grain weight in one pod increased from 0.1 to 0.6 grams. Also, additional nitrogen fertilization increased the weight of grain in one plant by 0.15-1.14 grams.

When winter wheat is fed with additional nitrogen, the efficiency of mineral fertilizers increases by two times. Also, when mineral fertilization is used on a scientific basis, it was observed that the quality of mineral fertilizers increased significantly.

Due to additional nitrogen fertilization, grain yield increased by 21-37 q/ha, protein content of grain by 0.6-1.7%, and gluten content by 1.2-4.5%.

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