

Conference Paper

Yield and Quality of Seeds of Wheat Varieties Tyumenskaya Jubilee and Tyumenochka Depending on the Level of Mineral Nutrition in the Northern Forest Steppe of the Tyumen Region

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Abstract

The State Agrarian University of the Northern Trans-Urals continues to breed spring wheat. Two varieties of Tyumen Jubilee and Tyumenochka have been created with the use of various source materials, including sources to the main cultural diseases in the region. Tyumenskaya variety has passed the State Variety Testing and is included in the Register of breeding achievements in 10 regions. The second variety is in the State Variety Trial. Research is continuing on both varieties to develop seed varieties. The results of influence of different levels of mineral nutrition on yield and quality of seeds of wheat varieties are analyzed in this report. It is established that in the northern forest-steppe zone of the Tyumen region on the natural fertility of leached black soil the average seed yield for three years was for the variety Tyumenskaya jubilee 2.48 t/ha, for Tyumenochka -- 2.08 t/ha. In the variant with application of mineral fertilizers to the planned yield of 4 t/ha, the first grade seed was obtained 3.29 t/ha, the second -- 2.91. The additions to the control variant were 0.81 and 0.83 t/ha. When applying mineral fertilizers to the yield of 5 and 6 t/ha, the additions remained at the level of the previous version, except for the Tyumenochka variety in the last version. The yield of seeds from the total yield in the control variant was 75.5 % for the variety Tyumenskaya jubilee and 71.7 % for Tyumenochka. In the variant with NPK by 4 t/ha the yield of seeds increased by 4.2 % in the first grade and by 4.5 % in the second grade. Protein content in the seeds of wheat varieties on the natural soil fertility was 13.6 and 12.3 %, respectively. The maximum content of 16.0 and 14.8 % is noted in the variant with fertilizers for the planned yield of 4 t/ha. In the same variant the highest germination energy (82.3, 80.1 %) and germination of seeds (96.9 and 95.5 %) are higher than the control variant by 20.7, 15.6 and 1.8 %; 2.5 % accordingly. The main part of the seeds (71.0 and 68.1 %) of the studied wheat varieties in the mentioned variant grew with 5--6 germ roots that is 19.3 and 13.2 % higher than the control. The variant with fertilizers for the planned yield of 4 t/ha was more economically advantageous, the level of profitability of the variety Tyumenskaya jubilee was 49 %, and Tyumenochka 44 %.

Keywords: spring wheat, variety, seeds, yield, germination energy, germination.

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1. Introduction

The breeding of spring wheat was started in the former Tyumen Agricultural Institute (now the State Agrarian University of the Northern Urals) in 1974: Over the past period of time, four varieties have been created and included in the Register of Breeding Achievements: Tyumenskaya 80, Angara 86, Bel, Tyumenskaya jubilee and one variety Tyumenochka passes the State variety testing [2, 6]. Of these, the Tyumen Jubilee Variety Trial and the Tyumenochka Variety Trial were created in the last decade. The first variety of medium early, semi-intensive type gives stable yield on the average background of nutrition and has an advantage over the intensive type [8]. At a high background of nutrition, it is close in yield to intensive varieties. The variety is most suitable for farms with an average level of crop cultivation. Such farms in the Tyumen region and Siberia as a whole make up 60–70 % of their total number. Tyumenskaya variety passed the state variety testing and in 2018 was included in the register of breeding achievements in the West Siberian region.

The second grade of Tyumenochka is being tested by the State Variety Testing. It is of the intensive type, medium early, well matured in different weather years. High yield is given by the best predecessors: clean and green fallow, early potatoes, peas, perennial herbs. The variety is designed for farms with a high level of farming culture.

Promotion of new varieties of wheat in production depends on the development of elements of technology of their cultivation for seed purposes [9, 18]. Special attention is paid to the level of mineral nutrition [12–17]. In this regard, the aim of the research is to study the yield and quality of seeds of wheat varieties Tyumenskaya jubilee and Tyumenochka depending on the level of mineral nutrition in the northern forest steppe of the Tyumen region.

2. Subjects and Methods

The research was conducted in 2016–2018 in the northern forest-steppe of the Tyumen Region in the experimental field of the State Automobile Inspection of the Northern Trans-Urals. The soil is leached chernozem, heavy loamy in terms of granulometric composition, humus content is 7.2 %, phosphorus and nitrogen -- average, potassium -- high, the reaction of soil solution -- 6.7. Predecessor -- annual herbs (peas + oars). The technology is generally accepted for the culture in the region. Fertilizer application rate was calculated by the balance method on the planned yield. Sowing was carried out by the selection sowing machine SSFC-7 in optimal time. The area of the plot is 30

m², the record area is 25 m², the repeatability is 4-fold, and the placement of plots is randomized. Observations and records were carried out according to the methodology of the State variety testing of agricultural crops.

Quantity and quality of gluten -- according to GOST 27839-2013, ecological plasticity and adaptability were studied according to S.A. Eberhart and W.A. Russel as described by V.A. Zykin. Harvesting was carried out by the Sampo 130 combine harvester, yielding data were processed by the statistical method according to B.A. Dospheov (1985).

3. Results

In the conditions of short Siberian summer, as well as frequent spring-summer droughts and heavy precipitation in the second half of summer, it is important to set the level of mineral nutrition for each variety of wheat, at which the yield will be combined with the quality of seeds [9].

In this regard, the technology for seed sowing differs from the technology for commercial sowing. It is aimed at obtaining a moderately high yield combined with high quality seeds.

Wheat varieties react differently to the use of mineral fertilizers. The yield of new varieties of wheat, depending on the level of mineral nutrition, can be judged by Table 1.

From the data of Table 1 it is visible that natural fertility in the control variant has allowed to receive productivity of variety Tyumenskaya jubilee 3,31 t/ha, Tyumenochka 2,93 t/ha. When applying mineral fertilizers for 4 and 5 tons per hectare for both varieties, the yield is close to the planned one as compared to the previous variants. The yield of the Tyumenchka variety on the analyzed background of nutrition is higher than that of the Tyumen jubilee variety and amounted to 5.28 t/ha. Comparing the differences in yield between the variants and the NDS, the efficiency of all fertilizer rates was set at a 5 % significance level. The difference between the varieties is also statistically reliable.

The yield of the seed fraction depended on the variety, weather conditions of the year and the level of mineral nutrition (Table 2).

Seed yield of wheat varieties in the control variant was 2.08--2.48 t/ha. Tyumen jubilee variety had an advantage over Tyumenochka by 0.4 t/ha. In addition, he steadily formed the analyzed indicator by years. In terms of mineral nutrition levels by 4 and 5 t/ha, the addition to the control variant varied from 0.81 to 0.95 t/ha. At the maximum level of nutrition by 6 t/ha, the yield of seeds of the Tyumen jubilee variety was the

TABLE 1: Yield of wheat varieties depending on the level of mineral nutrition.

Variety	Yield, t/ha				To control, ±
	2016	2017	2018	average	
Control (without fertilizer)					
Tyumen jubilee	2.94	3.46	3.53	3.31	--
Tyumenochka	2.38	2.97	3.44	2.93	--
NPK of 4 t/ha					
Tyumen jubilee	3.84	4.32	4.26	4.14	+0.83
Tyumenochka	3.34	3.89	4.28	3.83	+0.90
NPK of 5 t/ha					
Tyumen jubilee	4.30	4.79	5.12	4.73	+1.42
Tyumenochka	4.32	4.76	5.08	4.72	+1.79
NPK of 6 t/ha					
Tyumen jubilee	4.41	4.83	5.30	4.84	+1.53
Tyumenochka	4.98	5.27	5.59	5.28	+2.35
HCP05	0.15	0.11	0.22	--	--
HCP05 for factor A (fertilizer rate)	0.10	0.08	0.16	--	--
HCP05 for interaction between B (grade) and AB	0.07	0.06	0.11	--	--

same as in the previous version, and of the Tyumenchka variety it increased by 1.55 t/ha as compared to the control.

The yield of the seed fraction from the total yield depending on the level of mineral nutrition can be judged by the data of Table 3.

From the analysis of the data in Table 3 it follows that the yield of seeds on the control variant in wheat varieties was 71.7--75.5 %. When applying mineral fertilizers to the planned yield of 4 t/ha, the yield of seeds of both varieties increased by 4.2--4.5 %. Further increase of mineral nutrition level on yield of 5 and 6 t/ha resulted in decrease of seed yield by 1.0--4.4 % in relation to the control variant. Thus, the maximum yield of seeds from the total yield provided the level of mineral nutrition on the planned yield of 4 t/ha.

It is important that the yield of wheat seeds is combined with their quality. In the zone of risky agriculture, where the Tyumen Oblast belongs, it is difficult to get seeds with high sowing qualities for many years. Since the second half of summer is characterized by high humidity and low air temperatures, it is necessary to select scientifically grounded

TABLE 2: seed yields of wheat varieties depending on the level of mineral nutrition.

Variety	Yield, t/ha				To control, ±
	2016	2017	2018	average	
Control (without fertilizer)					
Tyumen jubilee	2.39	2.56	2.49	2.48	--
Tyumenochka	2.38	2.97	3.44	2.93	--
NPK of 4 t/ha					
Tyumen jubilee	3.26	3.43	3.18	3.29	+0.81
Tyumenochka	2.69	2.92	3.12	2.91	+0.83
NPK of 5 t/ha					
Tyumen jubilee	3.28	3.45	3.56	3.43	+0.95
Tyumenochka	3.23	3.35	3.40	3.32	+0.84
NPK of 6 t/ha					
Tyumen jubilee	3.19	3.46	3.66	3.43	+0.95
Tyumenochka	3.57	3.64	3.68	3.63	+1.55
HCP05	0.28	0.07	0.31	--	--
HCP05 for factor A (fertilizer rate)	0.20	0.05	0.22	--	--
HCP05 for interaction between B (grade) and AB	0.14	0.04	0.16	--	--

doses of mineral fertilizers on seed crops. Otherwise, it is possible to obtain a high yield of seeds with low sowing rates.

The quality of seeds depends on their size, evenness, protein content and other parameters [1, 7, 10]. Seeds with a high protein content usually have high germination energy, germination and growth strength. When sowing in the field, they provide friendly, strong seedlings that ensure good sowing conditions in the future. The studied wheat varieties at different levels of mineral nutrition formed rather large seeds (Table 4).

The mass of 1000 grains in the control variant was 34.3 g for the Tyumenskaya variety and 33.5 g for the Tyumenchka variety. At introduction of mineral fertilizers under the yield of 4; 5; 6 t/ha the grain size of wheat varieties increased by 0,8–3,8 g, except for Tyumen anniversary in the variant for the planned yield of 6 t/ha. At all levels of mineral nutrition, the seed size of the Tyumenchka variety increased more compared to the Tyumen jubilee variety.

It is important to obtain not only large, but also leveled seeds. Seed evenness is understood to be the highest yield of seeds from two adjacent sieves when sorting the

TABLE 3: Influence of mineral nutrition level on seed fraction yield in wheat varieties.

Variety	Seed yield from total yield, %				To control, ±
	2016	2017	2018	average	
Control (without fertilizer)					
Tyumen jubilee	81.6	74.2	70.8	75.5	--
Tyumenochka	77.4	70.3	67.5	71.7	--
NPK of 4 t/ha					
Tyumen jubilee	85.1	79.4	74.4	74.7	+4.2
Tyumenochka	80.6	75.2	72.9	76.2	+4.5
NPK of 5 t/ha					
Tyumen jubilee	76.3	72.1	69.6	72.6	--2.9
Tyumenochka	74.8	70.5	67.0	70.7	--1.0
NPK of 6 t/ha					
Tyumen jubilee	72.4	71.8	69.1	71.1	--4.4
Tyumenochka	71.7	69.2	65.9	68.9	--2.8
HCP05	4.56	3.31	5.04	--	--
HCP05 for factor A (fertilizer rate)	3.22	2.34	3.56	--	--
HCP05 for interaction between B (grade) and AB	2.28	1.65	2.52	--	--

harvest. The studied varieties of wheat gave the maximum yield of seeds with a solution of 2.2x20 and 2.4x0 mm (Table 5).

In both types of wheat in the control variant, the seed evenness varied more over the years compared to the fertilized variants. On average, over three years the leveling of seeds on control was 92.0 % for the variety Tyumenskaya jubilee and 92.6 % for Tyumenochka. When fertilizers were applied to the planned yield of 4; 5; 6 t/ha, seed evenness of both varieties increased by 4.5--6.7 %.

The sowing qualities of seeds are positively influenced by their protein content. Protein accumulation in wheat seeds depended on the variety, mineral fertilizers and weather conditions of the year (Table 6).

The analysis of the data in Table 6 shows that the protein content in wheat grain in the control variant was 13.6 % in the Tyumenskaya jubilee variety and 12.3 % in Tyumenochka. Reliable increase in protein by 2.4--2.5 % was noted in both varieties when applying mineral fertilizers to the planned yield of 4 t/ha in Tyumenochka additionally

TABLE 4: Seed size of wheat varieties depending on the level of mineral nutrition.

Variety	Weight of 1,000 grains, g				To control, ±
	2016	2017	2018	average	
Control (without fertilizer)					
Tyumen jubilee	34.7	32.9	35.4	34.3	--
Tyumenochka	33.2	35.1	32.2	33.5	--
NPK of 4 t/ha					
Tyumen jubilee	34.9	34.1	37.6	35.5	+1.2
Tyumenochka	36.1	38.3	34.0	36.1	+2.6
NPK of 5 t/ha					
Tyumen jubilee	35.4	33.5	36.5	35.1	+0.8
Tyumenochka	36.9	39.3	35.8	37.3	+3.8
NPK of 6 t/ha					
Tyumen jubilee	34.7	33.0	34.9	34.2	--0.1
Tyumenochka	36.2	37.6	35.2	36.3	+2.8
HCP05	0.67	2.99	2.65	--	--
HCP05 for factor A (fertilizer rate)	0.47	2.11	1.87	--	--
HCP05 for interaction between B (grade) and AB	0.33	1.49	1.32	--	--

at the level of mineral nutrition by 5 t/ha. Other additions are within the limits of the error of experience.

Seed sprouting energy and germination are the main indicators of sowing qualities of seeds. The first indicator, although not controlled by GOST, but it is of great importance in obtaining dense shoots. From seeds with high enough laboratory germination, but not high energy of germination in the field can be rare shoots and not uniform further development of plants.

Tyumenskaya jubilee and Tyumenochka varieties in the years of research formed seeds on the control with the energy of germination 61.6--64.5 % respectively. At the same time, in conditions of favorable temperature in 2016, it was the maximum, and in conditions of cold and wet 2018. -- minimum (Table 7). At the level of mineral nutrition, the planned yield of 4 t/ha resulted in the formation of seeds with germination energy of 82.3 % in the variety Tyumenskaya jubilee and 80.1 % in Tyumenchka or increased by 20.7--15.6 % compared to the control.

TABLE 5: Level of wheat seeds depending on mineral nutrition level.

Variety	Alignment, %				To control, ±
	2016	2017	2018	average	
Control (without fertilizer)					
Tyumen jubilee	83.9	93.7	98.4	92.0	--
Tyumenochka	86.7	92.9	98.1	92.6	--
NPK of 4 t/ha					
Tyumen jubilee	96.3	98.9	98.9	98.0	+6.0
Tyumenochka	95.4	97.6	98.4	97.1	+4.5
NPK of 5 t/ha					
Tyumen jubilee	98.4	99.1	98.3	98.6	+6.6
Tyumenochka	97.3	98.7	98.5	98.2	+5.6
NPK of 6 t/ha					
Tyumen jubilee	98.9	98.6	98.7	98.7	+6.7
Tyumenochka	98.7	98.5	98.4	98.5	+5.9
HCP05	5.14	0.95	4.44	--	--
HCP05 for factor A (fertilizer rate)	3.63	0.67	3.14	--	--
HCP05 for interaction between B (grade) and AB	2.57	0.47	2.22	--	--

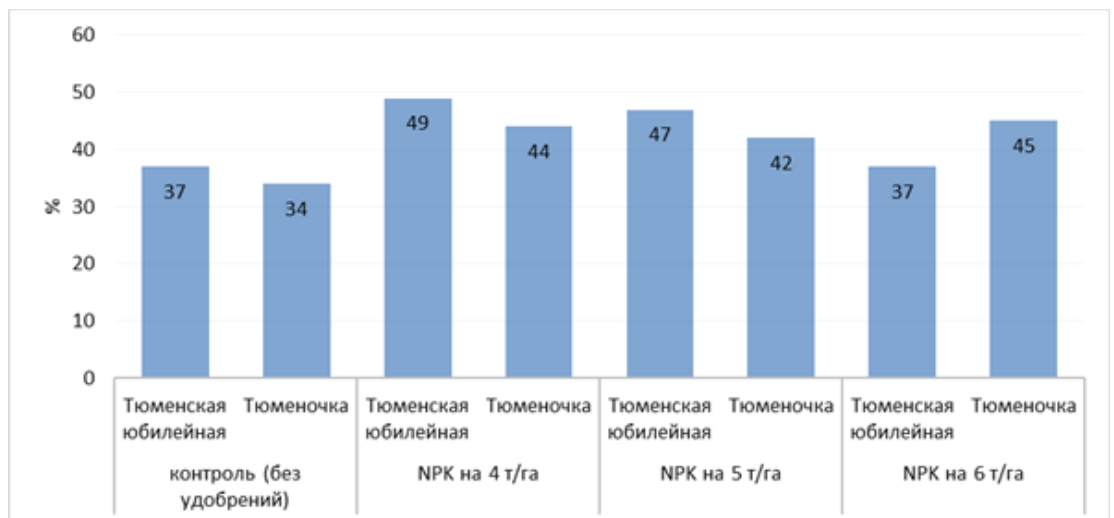


Figure 1: Profitability of application of mineral fertilizers when growing wheat varieties for seed purposes.

Introduction of mineral fertilizers under the yield of 5 t/ha increased the energy of germination of the obtained seeds by 13,7; 7,6 % in comparison with the control (without fertilizers), but the noted result was lower than the previous level of mineral nutrition by

TABLE 6: Effect of mineral fertilizers on protein accumulation in wheat seeds.

Variety	Protein content, %				To control, ±
	2016	2017	2018	average	
Control (without fertilizer)					
Tyumen jubilee	13.4	13.5	13.9	13.6	--
Tyumenochka	12.1	12.3	12.7	12.3	--
NPK of 4 t/ha					
Tyumen jubilee	15.3	16.1	16.7	16.0	+2.4
Tyumenochka	14.8	14.5	15.2	14.8	+2.5
NPK of 5 t/ha					
Tyumen jubilee	14.2	14.7	14.5	14.4	+0.8
Tyumenochka	13.9	14.1	13.7	13.9	+1.6
NPK of 6 t/ha					
Tyumen jubilee	13.7	14.2	14.0	13.9	+0.3
Tyumenochka	13.2	13.6	13.1	13.3	+1.0
HCP05	3.67	0.37	0.52	--	--
HCP05 for factor A (fertilizer rate)	0.26	0.26	0.37	--	--
HCP05 for interaction between B (grade) and AB	0.18	0.18	0.26	--	--

7,0--8,0 %. Further increase of mineral fertilizers doses to the planned yield of 6 t/ha resulted in decrease of germination energy of the obtained wheat seeds by 7.6 and 5.2 respectively in comparison with the control variant.

The laboratory germination of seeds depended on the variety, year and level of mineral nutrition (Table 8). The maximum yield of the varieties under study was in 2016, while the minimum yield was in 2018. In the control variant, it averaged 95.1 % for the Tyumenskaya jubilee variety and 93.0 % for Tyumenochka. Mineral fertilizer application to the planned yield of 4 t/ha allowed to obtain seeds with germinating power of 96.9 % for the first variety and 95.5 % for the second one, which is 1.8 % and 2.5 % higher than the control variant, respectively. Further increase of mineral nutrition level has led to decrease of laboratory germination of seeds by 2,3--6,2 % at grade Tyumenskaya jubilee and by 1,5--4,6 % at Tyumenochka. Therefore, the mentioned wheat varieties form seeds with high laboratory germination ability at the level of mineral nutrition on the planned yield of 4 t/ha.

TABLE 7: Wheat seed germination energy depending on the level of mineral nutrition.

Variety	Germination energy, %				To control, ±
	2016	2017	2018	average	
Control (without fertilizer)					
Tyumen jubilee	67.2	61.5	56.1	61.6	--
Tyumenochka	70.8	64.6	58.2	64.5	--
NPK of 4 t/ha					
Tyumen jubilee	89.6	85.3	72.0	82.3	+20.7
Tyumenochka	84.9	80.1	75.3	80.1	+15.6
NPK of 5 t/ha					
Tyumen jubilee	80.4	76.2	69.5	75.3	+13.7
Tyumenochka	75.8	77.6	63.1	72.1	+7.6
NPK of 6 t/ha					
Tyumen jubilee	59.3	52.7	50.2	54.0	--7.6
Tyumenochka	64.1	60.4	53.6	59.3	--5.2
HCP ₀₅	5.25	3.60	3.63	--	--
HCP05 for factor A (fertilizer rate)	3.71	2.54	2.57	--	--
HCP05 for interaction between B (grade) and AB	2.62	1.80	1.81	--	--

When creating the varieties Tymenskaya jubilee and Tyumenochka, the selection of primordial plants was carried out on the basis of a complex of economic features, including the number of germinal roots of seeds. Most of the collection varieties and wheat breeding lines we studied grow in three roots. The seeds of these varieties germinate by 50--60 % with five or six germ roots. The number of germ roots is an indirect indicator of the variety's resistance to spring-summer and prolonged summer droughts. This is a type of trait, but its manifestation also depends on weather conditions, precursor, mineral fertilizers and other factors. The influence of the mineral nutrition level can be seen from Table 9.

The data in Table 9 show that 51.7--54.9 % of the seeds of the studied wheat varieties grew with 5--6 roots in the control variant. When applying mineral fertilizers to the planned yield of 4 and 5 t/ha, the number of seeds with 5--6 roots increased in both varieties by 8.1--19.3 % compared to the control. The insignificant advantage remained behind the level of mineral nutrition by 4 t/ha. Fertilization by 6 t/ha resulted in a

TABLE 8: Laboratory germination of wheat seeds depending on the level of mineral nutrition.

Variety	Laboratory germination, %				To control, ±
	2016	2017	2018	average	
Control (without fertilizer)					
Tyumen jubilee	97.2	95.4	92.7	95.1	--
Tyumenochka	94.6	93.1	91.5	93.0	--
NPK of 4 t/ha					
Tyumen jubilee	98.3	97.6	94.8	96.9	+1.8
Tyumenochka	96.8	95.2	94.5	95.5	+2.5
NPK of 5 t/ha					
Tyumen jubilee	95.1	93.0	90.3	92.8	-2.3
Tyumenochka	92.7	90.8	91.2	91.5	-1.5
NPK of 6 t/ha					
Tyumen jubilee	90.3	89.6	86.9	88.9	-6.2
Tyumenochka	87.1	88.4	89.7	88.4	-4.6
HCP ₀₅	1.84	1.15	2.16	--	--
HCP05 for factor A (fertilizer rate)	1.30	0.81	1.53	--	--
HCP05 for interaction between B (grade) and AB	0.92	0.58	1.08	--	--

decrease in the number of seeds with 5--6 germ roots by 4.5--6.9 % relative to the control variant.

When studying any element of spring wheat cultivation technology it is important to know its economic efficiency (Figure 1).

It was more economically advantageous to apply mineral fertilizers to the yield of 4 tons per hectare, the level of profitability was 44--49 %.

4. Conclusion

Seed yield of wheat varieties Tyumenskaya jubilee and Tyumenochka 2.48; 2.08, respectively, was obtained on the natural fertility of leached black soil. The application of mineral fertilizers for the yield of 4 t/ha resulted in an increase in seed yield of both varieties by 0.81--0.83 t/ha. Further increase in the level of mineral nutrition did not contribute to the growth of seed yield, except for the variety Tyumenochka in the variant for the planned yield of 6 t/ha. The maximum yield of seeds from the total yield

TABLE 9: number of germ roots of wheat seeds depending on the level of mineral nutrition.

Variety	Seeds germinated with 5–6 roots, %				To control, ±
	2016	2017	2018	average	
Control (without fertilizer)					
Tyumen jubilee	57.3	52.8	45.1	51.7	--
Tyumenochka	61.9	54.5	48.4	54.9	--
NPK of 4 t/ha					
Tyumen jubilee	79.6	70.9	62.7	71.0	+19.3
Tyumenochka	74.8	68.5	60.9	68.1	+13.2
NPK of 5 t/ha					
Tyumen jubilee	77.0	69.1	63.5	69.8	+18.1
Tyumenochka	71.8	60.3	57.1	63.0	+8.1
NPK of 6 t/ha					
Tyumen jubilee	52.4	47.9	41.5	47.2	-4.5
Tyumenochka	56.2	44.7	43.1	48.0	-6.9
HCP05	2.25	2.65	1.71	--	--
HCP05 for factor A (fertilizer rate)	1.59	1.87	1.21	--	--
HCP05 for interaction between B (grade) and AB	1.13	1.32	0.85	--	--

of both varieties was at the level of mineral nutrition on the yield of 4 t/ha and amounted to 79.7; 76.2 %, respectively.

The variant with application of mineral fertilizers under the planned yield of 4 t/ha was identified by energy of germination and germination of seeds. Seed germination energy of both wheat varieties was 80.1–82.3 %, which is 15.6–20.7 % higher than the control, and germination was 95.5–96.9 %. The main part of seeds (68.1–71.0 %) in the mentioned variant germinated with 5–6 germ roots.

It was more economically advantageous to apply mineral fertilizers to the yield of 4 tons per hectare, the level of profitability was 44–49 %.

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