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Yield and Quality of Iren Wheat Grain Depending on Mineral Nutrition in the Tyumen Region

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Abstract

In the last decade, Ural and Siberian breeders have created a series of valuable and strong varieties of spring soft wheat, which have mainly successfully passed the State Variety Testing and are included in the Register of breeding achievements in 10 regions. These include the Irene variety, which is sown not only in Western Siberia, but also in Eastern Siberia and other regions of the country. It is well adapted to the conditions of the Tyumen region. The variety has been grown here for 13 years, but the variety technology has not yet been fully developed. It is cultivated according to generally accepted technology. Taking into account the current situation with the variety, we are conducting research on the development of elements of varietal technology. The article analyzes the results of the impact of mineral nutrition levels on the yield and quality of grain of spring soft wheat variety Irene in KRiMM Uporvo district of Tyumen region. Over the years of research (2016--2018), it was established that the leached black soil in the control version without mineral fertilizers yielded 2.57 t/ha of early maturing Irene variety. The variety reacts positively to the application of mineral fertilizers up to the yield level of 5 t/ha. At the same time, the yield is combined with the quality of grain. Profitability of application of mineral fertilizers for the yield of 4 and 5 tons per hectare was 130.7 and 139.5 %, respectively. In the control version it was 61.3 %. Irene variety is well adapted to the conditions of the Tyumen region, it is necessary to continue the study of other elements of the variety.

Keywords: spring soft wheat, variety, mineral fertilizers, yield, grain quality.

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1. Introduction

In recent decades, specialists of the State Variety Testing in the Tyumen Oblast have selected valuable and strong wheat varieties of the Urals and Siberian breeding for producers of goods [1--4]. Selection in this direction is being intensified in the Research institute of agriculture for Northern Trans-Ural and the State Autonomous Establishment of the Northern Trans-Ural State Agricultural University, valuable varieties of Tyumen

Anniversary, Tyumen 25 and 29, and Lutescens 70 have been created, although the main areas of sowing under the crop are Irene and Omsk 36 (valuable) and Novosibirsk 31 (strong) varieties [10, 11, 19, 21]. These varieties have quite a high yield potential combined with the quality of grain, but not always it is realized in production [5--8]. The fact is that in the region's varietal areas, due to the large load of variety experiments, it is not possible to study the elements of varietal technology, of which the level of mineral nutrition of wheat varieties is of particular importance [9, 12--14, 22].

Objective of the research: to study the influence of the level of mineral nutrition on the yield and quality of wheat grain of Irene variety in the northern forest-steppe of the Tyumen region.

2. Subjects and Methods

The research was conducted in LLC Agrofirm KRiMMM Uporovsky district. Soil is leached chernozem, medium loamy in terms of granulometric composition, humus content is 8.6 %, provision of nutrients is average, pH -- 6.5 [15, 16]. It was the predecessor of spring rape.

Soil treatment included dumped autumn ploughing to a depth of 28--27 cm, spring harrowing to retain moisture in the soil. Sowing was carried out by the sowing complex Vaderstat with simultaneous application of mineral fertilizers to the planned yield of 4--6 t/ha [17, 18]. Sowing time is optimal at soil temperature +13+15 °C, sowing rate is 6.2 million germ grains per hectare, sowing depth is 6--7 cm [19, 20]. The total area of the plot is 300 m^2, the record area is 200 m^2, the repeatability is 4-fold, and the plot location is systematic.

Sowing care consisted in carrying out before seed harrowing and chemical treatment against weeds in the phase of tillering. Observations and accounting were carried out according to the method of State variety testing (1986). Leaf area and photosynthesis productivity were studied according to A.A.'s method. The quality of grain -- according to the existing GOSTs. Yield data were processed, and correlation relations were calculated according to B.A. Dospekhov (1985).

Experiment framework: 1 -- control without fertilizers; 2 -- mineral fertilizers on 4 t/ha; 3 -- mineral fertilizers on 5 t/ha; 4 -- mineral fertilizers on 6 t/ha.

3. Results

Years of research have differed in weather conditions. Thus, 2016 was favorable in terms of temperature and water availability. At the same time, precipitation fell in accordance with the biological requirements of spring wheat. The grain matured in a timely manner and was successfully harvested. 2017 was also favorable for wheat growth and development, but precipitation was not as uniform as in 2016, although there was little and harvesting was quick. In this case, the costs of drying the grain are minimized. In 2018, air was slowly warming up, precipitation was abundant in May, and spring wheat sowing started in the third decade of May and ended in the first decade of June. Harvesting began at the end of the first ten-day period of September. Humidity of grain reached 22 % and more.

Years of research, especially in 2018, were difficult for the register varieties of wheat. Many of the varieties were harvested late, with a large loss of grain. The quality of grain was out of the question. In such difficult weather conditions, the Irene variety proved itself well, which once again emphasizes the expediency of cultivating the variety in the Tyumen region.

The influence of mineral nutrition levels on the duration of the growing season of Irene wheat can be seen from Table 1.

TABLE 1: The duration of the interphase periods of yerne wheat depending on the level of mineral nutrition, 2016--2018.

No.	Experience options	Period, day and night		
		Shoots heading	Heading ripeness	Shoots-ripeness
1	Control without fertilizer	39±2	41±4	80±3
2	Mineral fertilizers for 4 t/ha	42±3	46±5	88±4
3	Mineral fertilizers for 5 t/ha	44±3	48±5	92±4
4	Mineral fertilizers for 6 t/ha	45±4	52±4	97±5

In the control version of the studied variety of wheat on average for three years had the duration of sprouting -- earing 39 days, earing -- ripeness -- 41 days and sprouting -- maturity -- 80 days. With the increase in the level of mineral nutrition the period of sprouting -- earing increased by 3--6 days compared to the control. At passage of the second vegetation period the variety reacted more strongly to levels of a mineral food, thus the analyzed period has increased on 8--17 days, nevertheless, the variety has ripened in all years of researches that underlines high adaptability of a variety to conditions of the Tyumen area.

Important economic indicators are the density of shoots and the safety of plants for harvesting. It is necessary to note that in the conditions of production of the Tyumen region the noted signs of wheat varieties have not high indicators that negatively affects the yield. These signs depend, first of all, on the genotype of the variety, and then on the weather conditions of the year, fertilizers and other environmental factors.

Data on the density of shoots and safety of wheat plants for harvesting, depending on the levels of mineral nutrition are presented in Table 2.

Table 2: influence of different levels of mineral nutrition on the density of shoots and plant conservation for harvesting, 2016--2018.

No. n/a.	Experience options	Shoots density per m^2		Plant safety for harvesting on m^2	
		pcs.	%	pcs.	%
1	Control without fertilizer	523	87.2	487	81.2
2	Mineral fertilizers for 4 t/ha	541	90.1	512	85.3
3	Mineral fertilizers for 5 t/ha	550	91.5	528	87.1
4	Mineral fertilizers for 6 t/ha	547	91.2	523	86.4
	HCP_{05}	11	--	14	--

In the control variant, the variety Irene had a sprouting density of 87.2 %, i.e. quite high, and it was steadily manifested over the years. The safety of the plants for harvesting was 487 pcs/m^2, or 81.2 %. The mentioned signs, the variety inherited from the maternal form -- the variety Strela, which was cultivated in the past in the Tyumen region and annually differed from other register varieties by high rates of density of shoots and safety of plants for harvesting.

The use of mineral fertilizers increased the density of sprouting by 3--4 % and the safety of plants for harvesting by 4--6 %.

Yield depends on leaf area and photosynthesis productivity. Results of researches have shown (Figure 1), that in a control variant the area of leaves has made 27.3 thousand m^2/ha, productivity of photosynthesis -- 4.6 g.m^2/day. At introduction of mineral fertilizers on planned yield of 4 t/ha the area of leaves has increased to 35.6 thousand m^2/ha, productivity of photosynthesis -- 5.1 g.m^2/day and on planned yield of 5 t/ha the analyzed indicators have increased to 42.4 thousand m2/ha and 5.3 g.m^2/day accordingly. The further increase in the level of mineral nutrition on the planned yield of 6 t/ha, practically, did not increase the noted indicators.

The study of increasing doses of mineral fertilizers on spring wheat varieties is often accompanied by lodging of crops. At the same time, it should be noted that in the second half of the past and at the beginning of the current century the register of

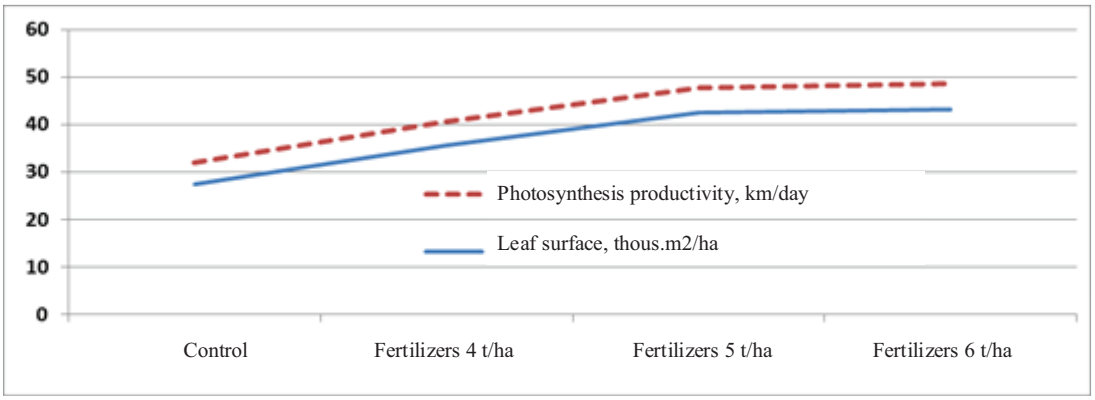

Figure 1: Leaf surface and productivity of photosynthesis of the Irene wheat variety depending on the level of mineral nutrition, 2016--2018.

breeding achievements in the Tyumen region and Siberia as a whole includes varieties that are quite resistant to lodging at a yield of 4--5 tons per hectare, and some of them at a yield of 6--7 tons per hectare.

The influence of mineral fertilizers on the height of plants of Irene variety and their resistance to lodging can be judged by the data of Figure 2.

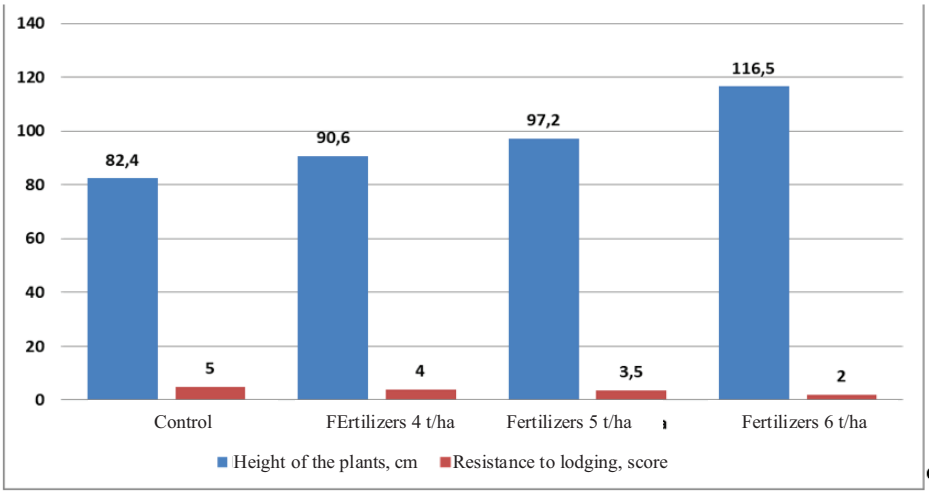

Figure 2: Influence of mineral nutrition on the height of Iren plants and their resistance to lodging, 2016--2018.

In the control variant, the height of wheat plants was 82.4 cm on the natural fertility of the soil, while the height of plants increased up to 90.6 cm when applying mineral fertilizers to the yield of 4 t/ha. In both variants of the experiment resistance to lodging is high (4--5 points). Further increase of mineral fertilizer doses in the planned yield of 5 t/ha and especially 6 t/ha reduced the resistance of plants to lodging. At height of plants 97,2 sm in a variant with a mineral food on productivity of 5 t/ha weak lodging was observed, but the sowing can be quite removed by combines. At a plant height of

116.5 cm in the variant with mineral nutrition for the grain yield of 6 t/ha there was a strong lodging of wheat sowing. At the same time, mechanized harvesting is difficult, and yield loss was 32 %.

Wheat yield is formed due to structural elements (Table 3).

TABLE 3: Yierre wheat yield structure depending on the level of mineral nutrition, 2016--2018.

Options	Safety of plants for harvesting on m^2, pcs.	Productive shrubbery	Grain in a spike, pcs.	Weight 1000 grains, g	A lot of grain from the spike, g
Control without fertilizer	472	1.1	16	36.2	0.61
Mineral fertilizers for 4 t/ha	508	1.3	19	37.9	0.83
Mineral fertilizers for 5 t/ha	514	1.3	22	38.7	0.98
Mineral fertilizers for 6 t/ha	511	1.2	23	37.4	0.95

In the variants with mineral fertilizers the safety of plants for harvesting increased by 36--42 pcs/m^2, and the best variant was the variant with application of mineral fertilizers to the planned yield of 5 t/ha. In the control variant it was kept for harvesting on a square meter of 472 plants.

Mineral fertilizers on yield of 5 t/ha favorably influenced the manifestation of productive bushiness, ear fineness, grain size and grain mass from ear. Thus, in the control variant the grain mass per spike was 0.61 g, in the variant with mineral fertilizers -- 0.98 g/ha or 0.37 g higher than in the control variant.

From the structural elements given in the table 3 the yield of wheat of Irene variety is formed. It should be noted that the structural elements contribute differently to the formation of yield. At the same time, a close positive relationship between the yield and the number of plants remaining for harvesting (r = 0.84--0.89), between the yield and the number of grains in the ear (r = 0.56--0.67), between the yield and the mass of grain from the ear (r = 0.79--0.91).

When studying any agricultural technique, the main indicator is yield (Table 4).

In the control variant the yield changed in the years of research from 2.39 to 2.81 t/ha, on average it was 2.57 t/ha. All this indicates that the fertility of fields in the farm is at a fairly high level.

Application of mineral fertilizers for the planned yield of 4 t/ha allowed to obtain 3.88 t/ha, which is 1.31 t/ha higher than the control variant. The increase in the mineral nutrition background to obtain 5 t/ha was fully justified, the yield here was 4.99 t/ha with fluctuations in years from 4.84 to 5.11 t/ha. Addition to the control variant was 2.42

Table 4: Influence of mineral nutrition on yerne wheat yields, 2016--2018.

Options experiences	Yield, t/ha				To control, ±	
	2016	2017	2018	average	t/ha	%
Control without fertilizer	2.39	2.81	2.53	2.57	--	100
Mineral fertilizers for 4 t/ha	3.72	4.06	3.87	3.88	+1.31	50.9
Mineral fertilizers for 5 t/ha	4.84	5.11	5.02	4.99	+2.42	94.1
Mineral fertilizers for 6 t/ha	4.75	4.97	4.89	4.87	+2.30	89.5
HCP05	0.18	0.21	0.14	--	--	--

t/ha or 94.1 %. For Irene, this level of mineral nutrition was the highest. Introduction of mineral fertilizers under the yield of 6 t/ha did not lead to the increase of yield.

In market conditions it is important to get high yield in combination with grain quality.

Table 5: quality of yerne grains depending on the level of mineral nutrition, 2016--2018.

Experience options	Nature of grain, g/l	Vitreousness, %	Protein, %	Gluten	
				content, %	group
Control without fertilizer	802	65	14.3	24.6	2--3
Mineral fertilizers for 4 t/ha	816	71	14.9	25.8	1--2
Mineral fertilizers for 5 t/ha	807	73	14.7	26.2	1--2
Mineral fertilizers for 6 t/ha	764	68	14.5	25.9	2--3
HCP05	12	7	0.9	0.5	--

Table 5 shows that Irene variety reacted positively to the application of mineral fertilizers, although a sharp improvement in the quality of grain was not registered. All variants of the experience obtained food grain, but its stable production is noted in the variants with mineral fertilizers for the planned yield of 4 and 5 t/ha.

When studying any agrotechnical methods it is important to know the economic efficiency.

The maximum profitability of 139.5 % was obtained in the variant with mineral fertilizers for the planned yield of 5 t/ha. In terms of profitability, 130.7 % is worthy of attention in the case of mineral fertilizers with a yield of 4 t/ha. For comparison, the profitability in the control variant was 61.3 %.

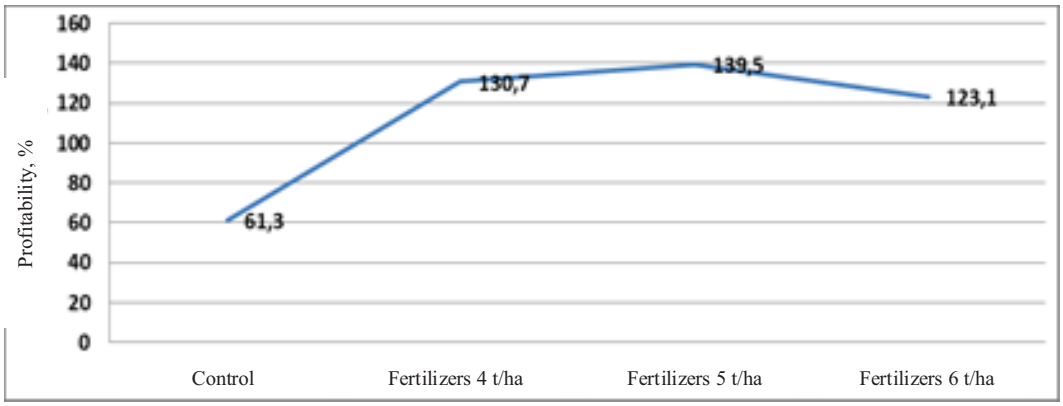

Figure 3: Profitability of mineral fertilizers for Irene wheat, 2016--2018.

4. Conclusion

Leached chernozem LLC KRiMMM Uporovsky district wheat variety Irene in the control version, without fertilizing, gave an average of three years yield of 2.57 tons per hectare. Grain quality was mainly suitable for baking industry.

The variety Irene reacted positively to the application of mineral fertilizers up to the yield level of 5 t/ha. At the same time, the yield is combined with the quality of grain. Profitability of application of mineral fertilizers for the yield of 4 and 5 tons per hectare was 130.7 and 139.5 %, respectively. Specifically, it was 61.3 %.

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