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PRODUCTIVITY AND QUALITY INDICATORS OF GRAIN BARLEY DEPENDING ON VARIETY FEATURES AND LEVEL OF MINERAL NUTRITION

Research article

Abstract

The article presents experimental data on the yield of various varieties of grain of spring barley, depending on the use of mineral fertilizers and their influence on the accumulation of mineral nutrition in barley plants and some economic valuable traits. The studies were carried out on ordinary black soil in the conditions of the central black earth. The influence of fertilizers on the content of nutrients in plants, yield and quality of grain on various varieties of spring barley is considered. It has been established that with an increase in the level of fertilization and the direct application of mineral fertilizers for barley, a significant increase in the yield and quality of barley grain is observed. The varietal characteristics of barley in response to the conditions of mineral nutrition are noted.

Keywords: variety, spring barley, yield, mineral fertilizer, agricultural products, fertilization level, grain quality, protein, starch.

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УРОЖАЙНОСТЬ И КАЧЕСТВЕННЫЕ ПОКАЗАТЕЛИ ЗЕРНА ЯЧМЕНЯ В ЗАВИСИМОСТИ ОТ СОРТОВЫХ ОСОБЕННОСТЕЙ И УРОВНЯ МИНЕРАЛЬНОГО ПИТАНИЯ

Научная статья

Аннотация

В статье приведены экспериментальные данные по урожайности различных сортов зерна ярового ячменя в зависимости от применения минеральных удобрений и их влияние на накопление минерального питания в растениях ячменя и некоторые хозяйственные ценные признаки. Исследования проводились на черноземе обыкновенном в условиях ЦЧЗ. Рассмотрено влияние удобрений на содержание элементов питания в растениях, урожайность и качество зерна на различных сортах ярового ячменя. Установлено, что с повышением уровня удобренности и непосредственном внесении минеральных удобрений под ячмень наблюдается существенное повышение урожайности и качества зерна ячменя. Отмечены сортовые особенности ячменя при реагировании на условия минерального питания.

Ключевые слова: сорт, ячмень яровой, урожайность, минеральное удобрение, агропрепараты, уровень удобренности, качество зерна, белок, крахмал.

1. Introduction

Barley is a valuable grain, food and industrial crop. In the Central Black Earth Region, in terms of sown areas and gross grain yield, barley occupies one of the leading places in the group of grain crops, but, despite this, the needs for feed and brewing grain are not fully satisfied. This is due to the unstable and low yields of this crop over the years. The solution to this issue is possible by observing and improving the technology of its cultivation and the introduction of new highly productive varieties [1, P. 131-132].

One of the key problems of agrochemistry is to determine the need for agricultural crops in fertilizers. This problem has acquired particular urgency at the present time in connection with the changed economic conditions. With a sharp increase in prices for mineral fertilizers, the issues of their rational use become even more urgent [2, P. 170-190]. Using well-known nitrogen, phosphorus and potash fertilizers, agricultural science is constantly looking for the most promising fertilizers and biological products that have a positive effect on the yield and quality of grown products [3, P. 15-16].

The fertilizer application system should not be developed for a particular crop as a whole, but taking into account the characteristics of a particular variety. This allows for a more rational use of mineral fertilizers and more accurately revealing the potential of productivity and quality of the variety. The existing methods for determining the dose of fertilizers in terms of obtaining the planned harvest are based on the indicators of the norms for the consumption of fertilizers for obtaining the crop or its increase, the norms for the removal of nutrients per unit of crop yield and the coefficients of their use from fertilizers and soil. The listed indicators are not differentiated by varieties, but are developed for crops as a whole, which does not allow calculating the fertilizer requirement of a variety with sufficient accuracy [4, P. 42-48].

Back in the early twentieth century, N.I. Vavilov raised the issue of the need to use varietal agricultural technology in growing grain crops. To date, considerable factual material has been accumulated, confirming the hypothesis of the unequal variability of the varietal response to the cultivation technology. Numerous literary sources reflect the peculiarity of different varieties to absorb and use nutrients from soil and fertilizers to varying degrees [5, P.120-161], [6, P.47-69], [7, P. 15-27].

2. Research methods

Scientific research on the development of methods for the combined use of mineral fertilizers and plant growth regulators in the technology of cultivation of spring barley in grain-row crop rotation was carried out in a stationary three-factor stationary experiment of the Research Institute of Agriculture named after V.V. Dokuchaeva (Stone Steppe). Research period 2018-2019. The culture is spring barley. The experience design includes two experience factors. The factor of the first order (levels of fertilization of crop rotation) - includes two levels of fertilization: 1 - without fertilizers; 2 - (NPK) 200. From the moment the experiment was laid (2011-2012), N0P0K0 and N720P540K540 (for the entire research period) were added to the first-order options, respectively. Immediately before the main tillage for barley, the first order variants were introduced: (NPK) 0, (NPK) 90. Factor of the second order - varieties of barley: 1 - Priazovsky 9; 2 - Icorec; 3 - Talovsky 9; 4 - Perspective line 13/14; 5 – Medicum-157; 6 - Oskolets.

The area of the plots of the last order (3.6 m × 11 m) is 39.6 m2. Mineral fertilizers were applied in autumn for the main tillage.

The background soil of the experimental site is represented by segregation (ordinary) black soil, medium-thick, medium-humus, heavy loamy granulometric composition. The humus content in the 0-30 cm layer is 6.39%, the pH of the salt extract is 6.0, the hydrolytic acidity is 1.67 ME / 100 g, the amount of absorbed bases is 46.1 ME / 100 g of soil, gross nitrogen content - 0.297%, phosphorus - 0.170%, potassium - 1.82%. The content of mobile forms of phosphorus and potassium ranges from 70 to 120 and from 65 to 115 mg / kg of soil, respectively.

3. Results and discussion

During the growing season of spring barley plants, climatic conditions had their own characteristics. Average annual air temperature for the growing season of barley (April-July) in 2018 and 2019 was higher than the norm by 1.4 and 1.5 ° C, respectively (norm 15.7 ° C). In terms of the amount of atmospheric precipitation, a significant shortfall was noted during this period: with an average annual rate of 196 mm, 125 mm fell in 2018, and 129 mm in 2019.

Judging by the moisture coefficient (K), barley plants experienced a lack of moisture, especially in the first half of the growing season. So, in May, with an average long-term value of Ku 0.41 over the years of research, it was 0.14 (2018) and 0.31 (2019). The moisture conditions were even more severe in June. Ku was 0.02 and 0.22, respectively, with an average long-term value of 0.46.

As part of our work, we have evaluated the dynamics of changes in the content of mineral elements in the vegetative mass of various varieties of barley, depending on the background of fertilization (Table 1).

Table 1 – Change in the content of elements of mineral nutrition in barley plants during the growing season, 2018-2019 (%absolutely dry matter)

Fertilization option	Barley variety	Plant development phases					
		Trumpet			Earing		
		N	P	K	N	P	K
No fertilizers	Priazovsky	2,00	0,78	1,60	1,43	0,60	1,17
	Ikorec	2,01	0,83	1,82	1,36	0,59	1,09
	Talovsky 9	1,90	0,64	1,83	1,48	0,48	1,33
	Perspective line 13/14	2,47	0,78	1,92	1,64	0,65	1,25
	Medicum 157	1,97	0,67	1,67	1,55	0,59	1,22
	Oskolets	1,96	0,69	1,86	1,62	0,59	1,38
	Average	**2,05**	**0,73**	**1,78**	**1,51**	**0,58**	**1,24**
$N_{90}P_{90}K_{90}$	Priazovsky	2,27	0,79	2,28	1,50	0,59	1,33
	Ikorec	1,99	0,74	2,02	1,42	0,60	1,44
	Talovsky 9	2,06	0,67	2,16	1,50	0,57	1,34
	Perspective line 13/14	2,37	0,68	2,12	1,69	0,56	1,41
	Medicum-157	2,16	0,74	2,01	1,47	0,53	1,27
	Oskolets	2,13	0,74	2,23	1,56	0,51	1,32
	Average	**2,16**	**0,73**	**2,13**	**1,52**	**0,56**	**1,35**

At the initial stages of plant development, the highest concentration of nutrients in them is characteristic. The varietal characteristics of the culture had a significant impact on the accumulation of nutrients in plants during the booting phase. The maximum nitrogen content was noted in the Perspective line 13/14 variety - 2.47% (on the option without fertilization) and 2.37% (against the background of $N_{90}P_{90}K_{90}$). The minimum value against a non-fertilized background was 1.90% in the Talovskiy 9 variety, and 1.99% against a fertilized background in Ikorets plants. The application of N90P90K90 to barley provided an increase in the nitrogen content in plants of the Priazovsky variety by 13.0%, the Medicum 157 variety by 9.6%, the Oskolets variety by 8.7% and the Talovsky 9 variety by 8.4%. The varieties Ikorets and Perspective line 13/14 did not respond to the improvement of the agricultural background by increasing the nitrogen content in plants.

In the phase of earing of barley, a decrease in the concentration of mineral nutrition elements in the vegetative mass was noted by 26-30% in nitrogen, 20-23% in phosphorus and 37-40% in potassium. On uncomfortable and fertilized backgrounds, the indicators for nitrogen content converged and the gap in potassium content decreased. During this phase of growth and development of barley, varietal differentiation according to the content of elements of mineral nutrition in plants was also preserved. The highest nitrogen content continued to remain in the Perspective line 13/14 variety: against an uncomfortable background - 1.64 and on a fertilized one - 1.69%, the lowest - in the plants of the Ikorets variety, 1.36 and 1.42%, respectively.

Against the fertilized background ($N_{90}P_{90}K_{90}$), the nitrogen content in the plants was on average 5.4, and potassium - 19.7% more than on the unfertilized background. The application of phosphorus fertilizers did not affect the accumulation of phosphorus in plants.

In the middle of the growing season, differentiation was also preserved in the intake of nitrogen, phosphorus and potassium, depending on the varietal characteristics.

The account of the yield of barley in the experiment showed that the predominant influence on its value is exerted by the conditions of mineral nutrition, i.e. the norms of the use of mineral fertilizers for the crop, and possibly the aftereffect of the previously applied fertilizers in the crop rotation (Table 2). If on an unfertilized background, the yield of barley, regardless of the variety, was 1.62 t / ha, then on a fertilized background $N_{30}P_{30}K_{30}$ - 1.90 t / ha, which is 0.28 t / ha or 17.3% more. Increasing the fertilizer dose to medium ($N_{60}P_{60}K_{60}$) and high ($N_{90}P_{90}K_{90}$) fertilization levels provided an increase in yield by 0.47 or 29.0% and 0.64 t / ha or 39.5%.

Table 2 – Yield of spring barley at different levels of fertilization, t / ha

Fertilization option (factor A)	Varieties (factor C)						Average by varieties
	Priazovsky 9	Ikorec	Talovsky 9	Perspective line 13/14	Medicum	Oskolets	
$N_0P_0K_0$	1,63	1,53	1,66	1,64	1,80	1,47	1,62
$N_{30}P_{30}K_{30}$	1,79	1,75	1,89	2,02	2,17	1,80	1,90
$N_{60}P_{60}K_{60}$	2,00	1,97	2,15	2,20	2,25	1,95	2,09
$N_{90}P_{90}K_{90}$	2,16	2,06	2,31	2,43	2,42	2,18	2,26
NDS 0.5 t / ha, factor C = 0.17 t / ha							

Varietal characteristics of barley had a significant impact on grain yield in the experiment. On average, regardless of the level of fertilization with mineral fertilizers, the highest grain yield was provided by the Medicum-157 variety - 2.16 t / ha. The productivity of the Perspective line 13/14 variety was 4.3% lower, the Talovskiy 9 variety - by 8.0%, the Priazovskiy 9 variety - by 14.3%, the Oskolets variety - by 16.8% and the Ikorets variety - by 18.0%.

By purposefully regulating the conditions of mineral nutrition, to a large extent, it is possible to influence the change in the quality indicators of agricultural products (Table 3). Against the background without the use of fertilizers, the smallest content of nitrogen and protein in barley grain was observed in the Ikorets variety - 2.07 and 11.9% absolutely dry matter. According to this indicator, this variety can be recommended for cultivation for brewing purposes. The highest protein content was obtained in the grain of the Priazovsky varieties - 2.24 and 12.9%, Talovsky 9 - 2.19 and 12.6% and Medicum 157 - 2.17 and 12.5% absolutely dry matter. These varieties can be used for feed purposes. The rest of the varieties in their characteristics have border values between brewing and feed.

Against the background of N90P90K90, all varieties, with the exception of the Oskolets variety, can be classified as fodder in terms of protein content in grain. It should be noted that the Oskolets variety, on average, showed itself outside the box in two years. With an increase in the background of fertilization, in contrast to other varieties, the protein content in the grain of the Oskolets variety decreased.

Table 3 – Qualitative indicators and chemical composition of grain of spring barley varieties without the use of agrochemicals, % absolutely dry matter

Fertilization option	Variety	Qualitative indicators		Chemical composition		
		protein	starch	N	P_2O_5	K_2O
$N_0P_0K_0$	Priazovsky 9	12,9	53,3	2,24	0,70	0,47
	Ikorec	11,9	55,9	2,07	0,69	0,46
	Talovsky 9	12,6	56,7	2,19	0,72	0,42
	Perspective line 13/14	12,1	56,0	2,10	0,70	0,43
	Medicum 157	12,5	54,9	2,17	0,75	0,45
	Oskolets	12,2	56,1	2,12	0,72	0,40
$N_{90}P_{90}K_{90}$	Priazovsky 9	13,3	55,3	2,32	0,67	0,41
	Ikorec	13,7	55,9	2,39	0,66	0,42
	Talovsky 9	13,5	56,0	2,35	0,63	0,40
	Perspective line 13/14	12,6	56,2	2,19	0,67	0,36
	Medicum 157	13,1	55,1	2,28	0,68	0,37
	Oskolets	11,5	53,1	2,00	0,68	0,39

In terms of starch content, no significant changes were found in the studies depending on the background of mineral nutrition. The average values on the natural and mineral background of nutrition were practically equivalent - 55.5 and 55.3% of absolutely dry matter. To the greatest extent, the starch content was determined by genetic varietal characteristics. Against the background without fertilizers, its greatest amount was noted in the varieties Talovskiy 9, Oskolets and Perspective line 13/14 - 56.7-56.0%. Against a fertilized background, the Talovskiy 9 varieties retained a higher starch content - 56.0 and 56.2% of absolutely dry matter.

The application of a complete mineral fertilizer for barley ($N_{90}P_{90}K_{90}$) reduced the content of phosphorus and potassium in the grain of all barley varieties by an average of 0.05 absolute percent. In relative percentages for phosphorus, this is 6.3%, and for potassium - 10.6% absolutely dry matter. The largest decrease in the phosphorus content in grain grown on a fertilized background was noted in the varieties Talovskiy 9 and Medicum 157, and the decrease in the potassium content in the varieties Medicum 157 and Perspective line 13/14.

4. Conclusion

Thus, the varietal characteristics of spring barley, as well as mineral fertilizers and the direct increase in their doses applied to barley, have a significant impact on the accumulation and dynamics of mineral nutrition elements in plants, an increase in yield, quality indicators and the chemical composition of barley grain.

The conditions of mineral nutrition in the soil, created by the application of mineral fertilizers under the barley and the aftereffect of the earlier applied fertilizers in the crop rotation, had the greatest influence on the increase in the yield of barley. Compared to the unfermented background against the background of $N_{30}P_{30}K_{30,}$ grain harvest increased by 17.3%, against the background of $N_{60}P_{60}K_{60}$ - by 29.0% and against the background of $N_{90}P_{90}K_{90}$ - by 39.5%.

In terms of the starch content against an unfertilized background, the highest value was found in the grain of the Talovskiy 9 variety - 56.7%, the lowest - in the Priazovskiy 9 variety - 53.3%. Against the fertilized background, compared with the unfertilized one, the starch content in the barley grain increased by 2% in the Priazovskiy 9 variety and decreased by 3% in the Oskolets variety. In other varieties, it remained at about the same level as against the background without fertilizers.

Conflict of Interest

None declared.

Конфликт интересов

Не указан.

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