UDC 664.71-11.001.32

PROTEIN AND STARCH CONTENT IN WINTER RYE GRAIN DEPENDING ON THE KINDS, NORMS AND TERMS OF NITROGEN FERTILIZATION

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The article studies the formation of protein and starch content in the grain of winter rye depending on the norms and terms of nitrogen fertilization. It is proved that the grain of winter rye is characterized by good baking properties as the protein content by nitrogen fertilization does not exceed 11,5%, but the starch content decreases from 61.9% to 59.6%.

Keywords: *winter rye, nitrogen fertilizers, protein, starch*

Introduction. Grain products contain essential for the human body nutrients. They are rich in carbohydrates, proteins, they have fat and minerals. Baked bread contains vitamins B1, B2, PP and E. While eating bread a person gets from 30 to 50% of the energy necessary for life-sustaining activity, up to 40% of the demand in the protein, 60% of vitamin C, 80% of vitamin E [1].

Rye is one of the major food crops, its corn is used for the production of bakery flour. Rye bread has high nutritional properties. Besides bread, rye and its derivatives are used as fodder for farm animals, as well as for the production of alcohol, starch and malt. Valuable feed products are the green mass of winter rye [2].

Different kinds, norms and terms of fertilizer application acted on the yield of winter rye **in various ways**. Thus, according to R.B. Nurlyhayanov [9], spring nitrogen fertilizing significantly aides the yield of winter rye, improves physical and nutritional quality of grain. Late foliar nitrogen application usually has no impact on the yield, but increases the protein content in grain. While applying nitrogen fertilizers, baking performance of rye slightly reduced [1, 10]. Foliar application increases vitreousness and crude protein content in winter rye. Thus, protein content in the control variant was

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10.9%, and during grain-filling period - 12,7-13,1% (while applying fertilizers)[2]. Balanced inorganic nutrition improves productivity of winter rye by increasing the grain weight and protein content in it [3].

Due to the presence of hazardous substances in the grain of rye, its use is limited. However, the 5- alkylresorcin content in larger grains is lower because this compound occurs in pericarp and does not exist in the endosperm and grain kernel. The most important indicators of the grain quality of winter rye is grain unit, falling number, protein content, vitreousness, that should be studied within the interconnect system of kinds and growing season conditions [5].

Carbohydrates are the main part of the rye grain. Among the carbohydrates first place takes the starch (56-64%), other carbohydrates such as sugars, dextrin, and gel cellulose pentosans take about 10%. Starch plays an important role in the preparation technology of rye dough and bread. It focuses in the endosperm of grain and is stored there in the form of starch grains of different sizes [2, 3].

The protein content in grain rye can vary from 6% to 17% [4]. As opposed to the wheat the increase of protein in rye grain usually does not cause an increase in the volume of bread. That’s why with winter rye you must apply as much nitrogen fertilizers that grain protein content did not exceed 11.5%. By higher content its alpha amylase activity increases [5].

The materials and methods of research. The variety of winter rye Intensive 95 was cultivated on podzolized loamy chernozem in experimental field of Uman National University of Horticulture during 2010-2012. The experiment was laid according to the scheme 1) no fertilizers, control, 2) R60K60 - background (1), 3) K60 + N60(2) 4) R60 + N60(2), 5) background + N30(2), 6) background + N60(2), 7) background + N90(2), 8) background + N0(2) + N30 (3), 9) background + N0(2) + N60 (3) 10) background + N30(2) + N30(3) 11) background + N60(2) + N30(3) 12) background + N30(2) + N60(3) 13) background+ N60(2)+N60(3). Phosphate and potash fertilizers (background) were put during primary tillage (1), and nitrogen fertilizers in early spring (2) and the period of intense tillering (3). The total area of the experimental plot in the experiment was 72 m², calculation - 40 m², repetition of the experiment was thrice

repeated, and placement of sites was consistent. Yields were determined by direct combine harvesting, for qualitative evaluation in grain of winter rye protein content was determined according to DSTU 4117:2007, the starch content according to GOST 10845-76.

Mathematical treatment of experimental materials was performed by the method of dispersion analysis of one-way field experience using standard software package "Microsoft Excel 2003".

Results of the research. As a result of the research it was determined that on the average in three years of research the protein content in the grain of winter rye in the variant without fertilizers was 8.0% and increased to 8,2-8,9% in variants with the applying of $N_{30–90}$ in early spring (Table 1). In the variants with the transfer of N_{30} and N_{60} in nourishment at the beginning of boot stage of winter rye the levels were 8.4% and 8.8%, which was significantly higher compared with variants, where these norms were applied in early spring.

For retail application of nitrogen fertilizers protein content was the highest in variant background + $N_{60\ (II)}$+ $N_{60\ (IV)}$ and was 9.3%. The application of phosphorus-potassium fertilizers helped to increase the protein content to 8.1%, and after applying K_{60}+ $N_{60(II)}$ and P_{60}+ $N_{60(II)}$, it increased by 8.3 and 8.4%.

Lack of moisture and high air temperature during the ripening of winter rye in 2010 and 2012 contributed to the increase in protein content. Therefore its content as compared to 2011 was higher and ranged from 8,1 to 9,5%. In 2011, without fertilizers it was 7.8% and in variant background + $N_{60\ (II)}$ + $N_{60\ (IV)}$ 8,9 %.

Grain of winter rye is characterized by the high content of starch. Thus, on average over three years of research unfertilized plots its content was 61.9% and decreased to 60,9-60,1% by applying $N_{30–90}$ in early spring to 60,5-59,6% in variants with double nutrition (Table 2).

1. Protein content in the grain of winter rye depending on norms and terms of nitrogen fertilization, %

Research variant	Research year			Average for three years of the research
	2010	2011	2012	
Control (without fertilizers)	8,1	7,8	8,2	8,0
$P_{60}K_{60}$ – background	8,1	7,8	8,3	8,1
K_{60}+ $N_{60\ (II)}$	8,4	8,1	8,5	8,3
P_{60}+ $N_{60\ (II)}$	8,4	8,1	8,6	8,4
Background + $N_{30\ (II)}$	8,2	8,0	8,4	8,2
Background + $N_{60\ (II)}$	8,7	8,3	8,8	8,6
Background + $N_{90\ (II)}$	9,0	8,7	9,1	8,9
Background + N_0 + $N_{30\ (IV)}$	8,4	8,1	8,6	8,4
Background + N_0 + $N_{60(IV)}$	8,9	8,5	9,0	8,8
Background + $N_{30\ (II)}$+ $N_{30(IV)}$	8,7	8,3	8,9	8,6
Background + $N_{60\ (II)}$+ $N_{30(IV)}$	9,1	8,7	9,2	9,0
Background + $N_{30\ (II)}$+ $N_{60(IV)}$	8,8	8,3	9,0	8,7
Background + $N_{60\ (II)}$+ $N_{60(IV)}$	9,4	8,9	9,5	9,3
HIP_{05}	*0,5*	*0,4*	*0,6*	

Starch content in grain of winter rye was significantly different during the years of research. In 2010, it was 59,6-62,3%, in 2011 - 61,1-63,2, in 2012 - 58,0-60,1%, depending on the variant of the research.

2. Protein content in the grain of winter rye depending on norms and terms of nitrogen fertilization, %

Research variant	Research year			Average for three years of the research
	2010	2011	2012	
Research variant	62,3	63,2	60,1	61,9
	62,0	63,1	60,0	61,7
Control (without fertilizers)	61,3	62,7	59,8	61,3
$P_{60}K_{60}$ – background	61,2	62,8	59,9	61,3
K_{60}+ $N_{60\ (II)}$	61,0	62,4	59,4	60,9
P_{60}+ $N_{60\ (II)}$	60,4	62,1	59,1	60,5
Background + $N_{30\ (II)}$	60,0	61,7	58,7	60,1
Background + $N_{60\ (II)}$	61,8	62,9	59,8	61,5
Background + $N_{90\ (II)}$	61,5	62,4	59,4	61,1
Background + N_0 + $N_{30\ (IV)}$	60,7	62,0	58,7	60,5
Background + N_0 + $N_{60(IV)}$	60,2	61,6	58,1	60,0
Background + $N_{30\ (II)}$+ $N_{30(IV)}$	60,0	61,7	58,3	60,0
Background + $N_{60\ (II)}$+ $N_{30(IV)}$	59,6	61,1	58,0	59,6
Background + $N_{30\ (II)}$+ $N_{60(IV)}$	*3,1*	*3,3*	*3,0*	

Using regression analysis we found a strong inverse correlation (r = -0,85) between starch content in grain of winter rye and content of protein, which is described by the following equation regression:

$$Y = –1,7127x + 75,463, \qquad (4)$$

where y means starch content, %;

x – means protein content, % (fig. 1).

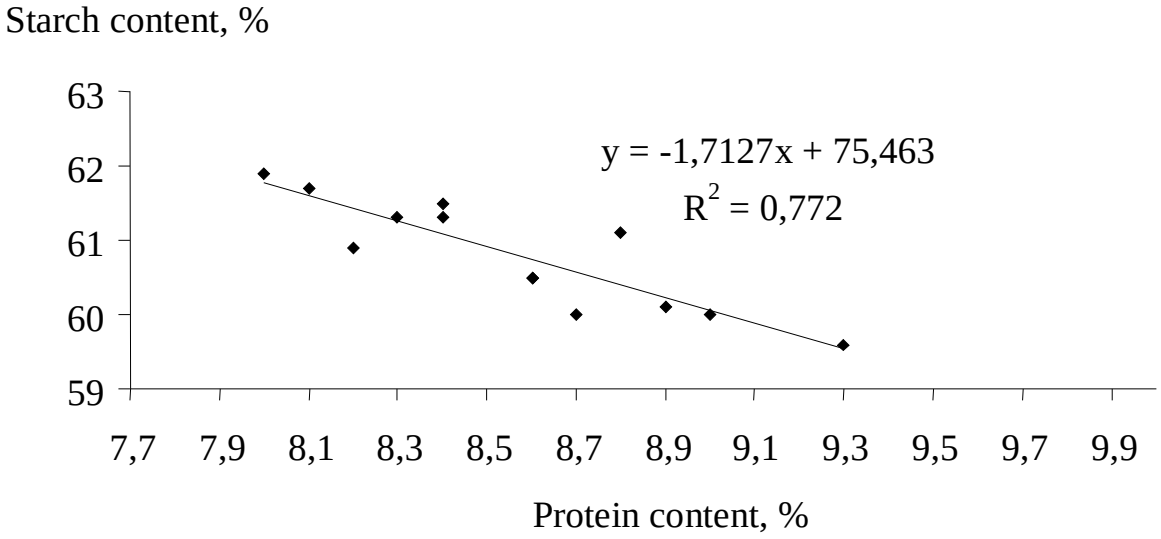

Figure 1. Correlation between starch content and protein content in the grain of winter rye, years 2010-2012

Conclusion

Improvement of the conditions of mineral nutrition of plants of winter rye helps to increase protein content in grain from 8.0% to 9.3% by applying $N_{60(II)}$+ $N_{60(IV)}$. Grain of winter rye is characterized by good baking properties as the protein content by applying nitrogen fertilizer does not exceed 11.5%, but the starch content decreases from 61.9% to 59.6%.

References

1. Agrochemical analysis / [M. M. Horodniy, A. P. Lisoval, A. V. Bukin et al.] – Kyiv : Aristey, 2005. – 468 p.
2. Adrianov S. N. Fertilizers and amino acid content of winter rye / S. N. Adrianov, H. T. Vorobiov // Cereals. – 1997. – № 1. – P. 19–20.
3. Holenkov V. F. The problem of quality and nutrition value of rye / V. F. Holenkov // Proceedings of VNIIZ. – 1971. – Issue 72. – P. 27–39.
4. Hospodarenko H. M. Agrochemistry / H. M. Hospodarenko. – Kyiv : Nichlava, 2010. – 350 p.
5. Yehorov D. K. Rye selection: prospects / D. K. Yehorov // Manual of Ukrainian farmer. – 2010. – P. 239.
6. Ismahilov R. R. Postharvest handling of rye bread-grain / R. R. Ismagilov, A. S. Samihulina, Sh. A. Samihulin / / Grain farming. - № 3. - 2001. - P. 39-41.

7. Krugliakov G. N. Commodity Merchandising / G. N. Krugliakov, G. V. Krugliakova. - Rostov-on-Don : March, 1999. - 448 p.
8. Mashynnyk S. V. The effectiveness of nitrogen fertilization of spring soft wheat on degraded chernozem of the Right-Bank Forest-Steppe of Ukraine : Extended abstract of candidate's thesis. – Kharkiv, 2007. – 20 p.
9. Nurlyhayanov R. B. The impact of nitrogen fertilizers on yield and quality of winter rye / R. B. Nurlyhayanov // Abstract Journal. – 2000. – № 5. – P. 25.
10. Pospelova L. S. Perennial and annual rye – valuable forage crops / L. S. Pospelova // Feed Production. – 2002 – № 4. – P. 20–21.
11. Tsiuk Y. V. Formation of agrocoenosis of winter rye and its productivity depending on the technology of cultivation in the northern part of the Forest Steppe of Ukraine: dis. … Candidate of agricultural sciences: 06.01.09. / Tsyik Yuliya. - Kyiv, 2007. - 172 p.