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

The formation of protein and starch content in the grain of winter rye depending on the norms and terms of nitrogen fertilizers are investigated in the article. 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, 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 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].

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].

Materials and methods. 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 and discussion. 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 %.

Table 1

Content of protein in the grain of winter rye depending on norms and terms of nitrogen fertilizers application, %

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*	

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).

Table 2

Content of protein in the grain of winter rye depending on norms and terms of nitrogen fertilizers application, %

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*	

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.

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:

$$Y = -1{,}7127x + 75{,}463, \quad (4)$$

where y means starch content, %;

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

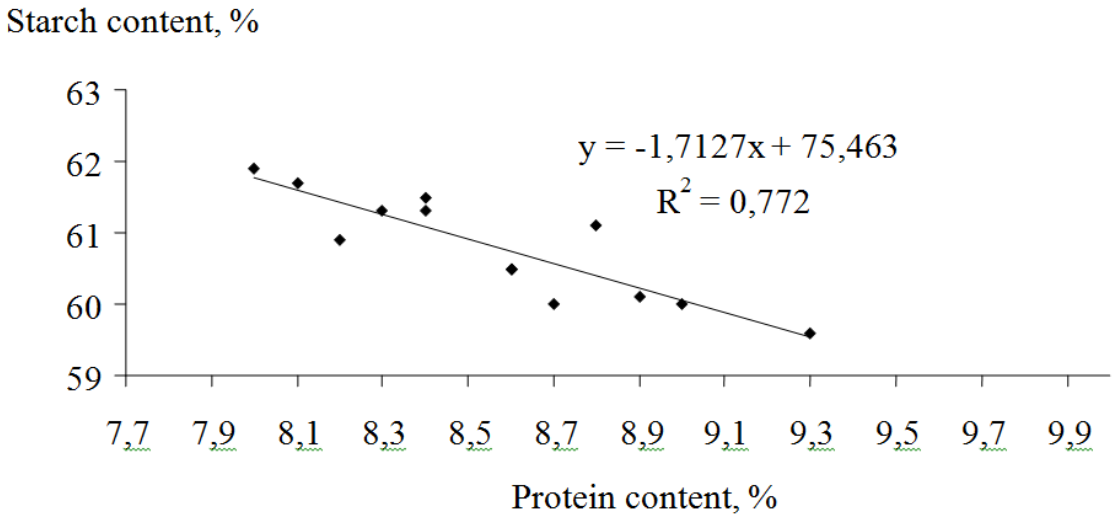

Fig. 1. Correlation between starch content in grain of winter rye and protein content, years 2010-2012

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%.

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Аннотація

Господаренко Г.М., Пташник М.М.

Вміст білка та крохмалю в зерні жита озимого залежно від видів, норм і строків внесення добрив

Досліджено формування вмісту білка та крохмалю в зерні жита озимого залежно від видів добрив, норм і строків азотних підживлень. Доведено, що зерно жита озимого за оптимального мінерального живлення характеризується хорошими хлібопекарськими властивостями, оскільки вміст білка при внесенні азотних добрив не перевищує 11,5%, але вміст крохмалю при цьому знижується з 61,9% до 59,6%.

Ключові слова: *жито озиме, мінеральні добрива, білок, крохмаль*

Аннотация

Господаренко Г.М., Пташник М.М.

Содержание белка и крахмала в зерне ржи озимой в зависимости от видов, норм и сроков внесения удобрений

Исследовано формирование содержания белка и крахмала в зерне ржи озимой в зависимости от видов удобрений, норм и сроков азотных подкормок. Доказано, что зерно ржи озимой при оптимальном минеральном питании характеризуется хорошими хлебопекарными свойствами, поскольку содержание белка при внесении азотных удобрений не превышает 11,5%, однако содержание крахмала при этом снижается с 61,9% до 59,6%.

Ключевые слова: *рожь озимая, минеральные удобрения, белок, крахмал*