PROTEIN COMPOSITION AND GRAIN QUALITY OF SPRING SOFT WHEAT *(TRITICUMAESTIVUM*L.) DEPENDING ON THE LEVEL OF NITROGEN NUTRITION AND PHYTOREGULATORS USE IN CASE OF CULTIVATION ON SOD-PODZOL MEDIUM LOAMY SOIL

N.N. Novikov, A.A. Zharikhina

(RSAU-MTAA)

Abstract: in experiments with spring wheat held on sod-podzol medium loamy soil, it has been found out that at the wheat plants 'productivity grows significantly when the level of nitrogen nutrition is increased. At the same time, the accumulation of gluten proteins in grain also increases, but so does the activity of α-amvlase in the mature grain and therefore gluten rheologicalproperties deteriorate. Foliar nitrogen fertilization of wheat in the early phase of grain formation enhances the accumulation of gluten proteins in it and reduces the activity of α-amvlase. A positive effect of phytoregulators epin-extra and albite on the technological properties of grain and marked effect of the nitrogen nutrition on the amylase activity in germinating grains has been revealed.

Key words: spring soft wheat; optimization of nitrogen nutrition; phytoregulators; grain quality; protein complement; proteins composition; amylase activity.

When wheat is cultivated in the climatic conditions of Non-chemozem zone, important goals are: correct selection of varieties that are capable of forming high-quality grain which will meet the requirements of processing industry, and improving cultivation technologies. At the same time, it is necessary to pay particular attention to building up an optimal plant nutrition regime for a plant. It especially refers to the nitrogen nutrition which has on impact not only on the formation of yield but also on its quality [2, 4, 7, 8, 11].

In experiments on the effect of fertilizers on the yield and grain quality of bread wheat it has been revealed that for the formation of high-quality seeds with improved technological properties it is necessary to provide plants with a specific diet, with the optimal ratio of nitrogen, phosphorus and potassium. Nitrogen deficit results in decreased productivity of the crop and the accumulation of storage proteins in caryopses also affecting their technological characteristics [1, 4, 9, 10, 16].

However, if high doses of nitrogen are applied before planting wheat, although grain and protein yield increases significantly but the rheological properties of gluten and the structural and mechanical properties of baking dough may worsen. It happens because the activity of hydrolytic enzymes in caryopses grows. In addition, as a result of increased nitrogen supply some changes in the grain protein take place negatively affecting its technological properties [7, 10, 11].

It should be noted that optimization of nutrition and use of phytoregulators influence the formation of wheat yield and the synthesis of storage proteins. These phytoregulators intensify physiological and biochemical processes in vegetating plants and biochemical changes in ripening grains [6, 11, 12, 15, 16, 18].

However, the effect of phytoregulators on the build-up of grain quality and metabolism in the vegetative mass and ripening wheat caryopses has not been sufficiently studied.

The objectives of our study was to examine the influence of environmental factors, plants' nitrogen nutrition and phytoregulators on the formation of yield, grain quality and storage protein composition of spring soft wheat cultivated on sod-podzol medium loamy soils in the Central District of Non-chemozem zone.

Material and methods

Studies of spring wheat cv. Ivolga were conducted at Oryol Field Research Station of RSAU-MTAA named in honour of K.A. Timiryazev in 2010-2011. The soil of the experimental plot was sod-podzol medium loamy, humus content — 2.4%-2.5%, P_2O5(according to Kirsanov's technique) — 200-220, K_2O (according to Maslova's technique) [14] — 160-180 mg per 1 kg of soil, pH of salt extraction - 5.8. The area of the plots - 1 m^2, repeated experiments were fivefold, seeding rate - 5.5 million viable seeds per 1 hectare. The experimental study on the wheat nitrogen nutrition mode included the following options: 1 - without nitrogen application (control), 2 - N60; 3 - N90; 4 - N120; 5-N150; 6-N150 + N30 (foliar nutrition), 7 - N120 + N30 (foliar nutrition). The basic dose of nitrogen was applied in the form of ammonium nitrate; nitric foliar nutrition of wheat was removed with urea in the early phase of the grain formation. Phosphorus-potassium diet - R20K20 (in the form of superphosphate and potassium chloride) was provided as a general background at all experiment plots.

When nitrogen was being applied in a dose of 150 kg/ha the effects of the following phytoregulyators - Albit, Epin-extra, Novosil and Ribav-extra were studied. Wheat plants were treated with phytoregulators at the heading stage in the following concentrations of the solution: Epin - 0.003, Ribav - 0.01, Albit - 0.003, Novosil - 0.006 ml/1, flow rate of the process solution - 30 ml/m^2.

Assessment of grain production data was carried out using standard methods [3]. The proteins composition has been studied by the solubility of the protein fractions in water, 10% solution of KC1, 70% solution of ethanol, 0.1% solution ofNaOH. The activity of amylolytic enzymes was identified by iodine-starch test, the amount of protein in the enzyme extract was measured according to Lowry's method [13]. Grains were forced to germinate in water at 25 °C. To diagnose the nitrogen nutrition of the plants, the levels of free amino acids have been determined in the leaf sap [10]. Diagnostics were performed using samples of vegetative mass, which included the second leaf from the top, taken from the main shoot of a plant at the stalk-shooting stage during the formation of the first stem node. Statistical processing of the experimental data was carried out according to B.A. Dospehov's technique [5] using relevant software modified at the Computing centre of RSAU-MTAA.

Research results

In 2010, during grain ripening, the wheat plants were exposed not only to the strong water stress but also to extremely high temperatures. So the wheat grain productivity was low (134-256 g/m^2). However, even in these circumstances there was a positive effect of nitrogen fertilizers applied to the crops. When nitrogen in a dose of 60 kg/ha was applied, a significant increase in plant productivity: from 134 to 157 g/m^2 — was noted (Table 1). Each successive increase in nitrogen dose by 30 kg/ha was also accompanied by a marked increase in wheat productivity. That was why the yield increase from the maximum nitrogen dose (150 kg/ha) equaled 76% with respect to the control (without nitrogen application).

In each of the variants with the increasing dose of nitrogen grain unit increased as well as such indicators as the weight of 1000 grains, grain hardness, wet gluten content. They significantly increased when high doses of nitrogen were applied (120-150 kg/ha), but there was a slight deterioration of rheological properties of gluten (increase in gluten deformation index). In the variant with the dose of 150 kg/ha compared to the control grain hardness increased by 10%, grain unit - by 47 g/l, weight of 1000 grains - by 3,9 g, wet gluten content - by 4.3%. At the same time, gluten weakening by 10 units of gluten deformation index was noticed. A grain with wet gluten content exceeding 28% (corresponding to the requirements for the strong wheat) formed when nitrogen doses of 120 and 150 kg/ha were applied, but gluten quality (second group) did not meet the requirements for the strong wheat in these variants.

Foliar nitrogen fertilization in the phase of grain formation had no significant effect on the productivity of wheat, grain hardness and weight of 1000 grains when applied nitrogen doses were 120 and 150 kg/ha, but caused the increase in wet gluten content in grains by 3.3 -3.5% without affecting its rheological properties (defined by gluten deformation

Table 1

Grain productivity, technological properties of grain and concentration of amino acids in wheat leaf sap in a field test, 2010

Variant	Grain yield, g/m^2	Grain hardness, %	Grain unit, g/l	Weight of 1000 grains, g	Wet gluten, %	Gluten deformation index, unit	Concentration of amino acids in leaf sap, mkmol of tyrosin per 1 ml
Control (without nitrogen application)	134	82	661	26.8	25.7	70	6.4
N60	157	85	673	27.2	25.9	73	5.7
N90	175	86	682	28.5	27.6	78	5.2
N120	210	87	694	28.4	28.5	78	4.9
N150	236	92	708	30.7	30.0	80	4.6
N150+N30; foliage application	240	90	707	29.7	33.5	81	x
N120+N30; foliage application	215	87	702	28.6	31.8	80	x
N150+Albit	247	88	715	30.7	29.2	80	x
N150+Ribav	243	87	710	29.5	30.1	80	x
N150+Epin	256	85	718	29.8	28.6	73	x
N150+Novosil	230	88	707	30.5	30.0	80	x
HCP_{05}	14	5	5	2.2	2	5	x

index). Late foliar nitrogen fertilization also contributed to the increase of grain unit in a variant with nitrogen dose of 120 kg/ha.

The main purpose of applying phytoregulators in our experiments was to study their effects on physiological and biochemical processes in the ripening grain that are connected to the formation of its quality. So the plants were treated with these regulatory substances at the heading stage. However, in the variant with Epin-extra, not only technological characteristics of grain (grain unit increases the elastic nature of gluten) improved but also a significant yield increase of wheat was gained. The positive effect of this regulator is obviously connected to its influence on the functioning of the plant cell membranes resulting in their increased resistance to water deficit and high temperature stress. Albit was found to increase grain unit, and Ribav-extra lowered grain hardness.

In more favourable weather conditions of 2011, grain yield in experiment exceeded that of 2010 by an average of 29%. Under the effect of increasing doses of nitrogen (up to 150 kg/ha) wheat productivity and grain unit grew significantly - by 47% and 38 g/l respectively. Grain hardness and wet gluten content increased only when high doses of nitrogen were applied - 120-150 kg/ha, the weight of 1000 grains - at doses of 90-150 kg/ha (Table 2). In the variant with a nitrogen dose of 150 kg/ha as compared to the

Table 2

Grain productivity, technological properties of grain and concentration of amino acids in wheat leaf sap in the field test, 2011

Variant	Grain yield, g/m^2	Grain hardness, %	Grain unit, g/l	Weight of 1000 grains, g	Wet gluten, %	Gluten deformation index, unit	Concentration of amino acids in leaf sap, mkmol of tyrosin per 1 ml
Without nitrogen application	201	80	710	28.5	24.4	70	5.6
N60	210	83	721	30.5	25.3	70	5.3
N90	254	80	731	33.7	25.8	65	4.6
N120	281	86	728	36.1	27.1	70	4.4
N150	296	85	748	38.4	27.8	75	4.4
N150+N30 foliage application	283	87	751	38.2	30.5	75	x
N120+N30 foliage application	285	83	738	35.5	29.7	75	x
N150+ Albit	302	87	750	38.5	27.8	75	x
N150+ Ribav	315	86	752	38.8	28.3	80	x
N150+ Epin	310	83	754	38.2	28.0	70	x
N150+ Novosil	295	85	748	38.1	27.5	80	x
HCP_{05}	15	5	5	2.1	2	5	x

control, one grain hardness increased by 5%, weight of 1000 grains by 9.9 g, wet gluten content by 3.4%. Also, slight weakening of gluten (by 5 units of gluten deformation index) was recorded.

Late foliar nitrogen fertilization, as in the experiment of 2010, had no substantial effect on wheat productivity but presowing nitrogen application of 120 kg/ha led to an increase in the grain unit by 10 g/l, the content of wet gluten by 2.6% (and reducing its elasticity by 5 units of gluten deformation index); presowing nitrogen application of 150 kg/ha resulted in an increase of wet gluten content in grain by 2.7% without changing its rheological properties.

In the growing season of 2011, a positive effect of the phytoregulator Ribav-extra on the productivity of wheat was noted however, it appeared to cause gluten weakening. Novosil had the same effect on gluten. Epin-extra increased grain unit and gluten elasticity.

Increasing doses of nitrogen (0-150 kg/ha) raised the overall accumulation of proteins in wheat caryopses by 4.2% (Table 3). It took place due to the increase of the proportion of gliadin and glutenin, while the concentration of albumins, globulins and non-extractable proteins decreased significantly.

The greatest effect on the action of late foliar nitrogen fertilization was obtained in the variant with presowing application of nitrogen in a dose of 150 kg/ha. At this time,

Table 3

The content and composition of proteins in wheat depending on nitrogen level and application of phytoregulators in a field experiment, 2010

Variant	Total content of proteins, %	Nitrogen of fractions, % from total proteins				
		Albumins and readily soluble globulins	Globulins	Gliadins	Glutenins	non-extrac table proteins
Without nitrogen application	10.5	13.3	13.7	28.8	31.2	13.0
N60	11.7	12.0	12.7	30.0	33.6	11.7
N90	13.0	12.3	12.6	30.5	34.4	10.2
N120	14.1	10.5	12.8	31.2	36.2	9.3
N150	14.7	10.2	11.5	31.5	37.8	9.0
N150+N30 foliage application	15.8	9.1	10.2	32.2	40.4	8.1
N120+N30 foliage application	14.7	9.8	10.9	32.0	38.6	8.7
N150+Albit	15.1	10.3	11.0	31.6	38.0	9.1
N150+Ribav	15.0	10.1	11.0	31.7	38.2	9.0
N150+Epin	14.5	10.3	11.3	31.5	37.6	9.3
N150+Novosil	14.4	10.5	11.4	31.3	37.4	9.4
HCP_{05}	0.5	0.3	0.5	0.5	0.4	0.4

protein content in the grain was increased by 1.1% due to the increase in gliadin and glutenin (gluten protein) content while the concentration of albumins, globulins and non-extractable proteins decreased. Studied phytoregulators in the vegetation period of 2010 had no significant effect on the content and composition of proteins in wheat.

With increasing doses of nitrogen applied to sowing, the level of a-amylase activity in the mature wheat caryopses increased. It produced a negative impact on the baking performance. This is particularly noticeable in the variant with a nitrogen dose of 150 kg/ha (Table 4, 5).

Foliage application of urea to wheat reduced substantially the activity of a-amylase in mature caryopses by some increase in p-amylase activity, which usually does not cause any deterioration of grain baking properties. A significant reduction in a-amylase activity

Table 4

Amylase activity in mellow and germinating grains of wheat harvested in 2010, mg of hydrolyzed starch per 1 mg of protein in 1 hr

Variant	Mellow grain		Duration of sprouting, days							
			1		3		5		7	
	α-amylase	β-aamylase	α-aamylase	β-amylase	α-amylase	β-amylase	α-amylase	β-amylase	α-amylase	β-amylase
Without nitrogen application	1.3	18.9	8	46	42	68	203	186	456	254
N60	1.5	20.2	10	52	48	65	244	178	483	218
N90	1.9	18.7	11	66	47	70	241	184	531	174
N120	2.1	21.7	14	67	55	78	270	137	554	83
N150	3.4	21.1	17	70	63	66	287	134	568	79
N150+N30 foliage application	1.5	24.3	17	68	72	69	223	135	511	101
N120+N30 foliage application	1.1	23.6	15	70	65	78	219	149	537	169
N150+Albit	2.3	22.1	17	70	65	66	277	103	539	66
N150+Ribav	2.8	21.9	17	68	68	70	281	136	502	125
N150+Epin	3.2	20.7	15	60	60	62	260	122	577	44
N150+Novosil	2.8	21.7	18	67	67	79	285	144	581	103
HCP_{05}	0.3	0.7	1.3	4.0	3.6	6.9	10.9	10.8	10.3	9.6

Table 5

Amylase activity in mellow and germinating wheat grains harvested in 2011, mg of hydrolyzed starch per 1 mg of protein in 1 hr

Variant	Mellow grain		Length of sprouting, days							
			1		3		5		7	
	α-amylase	β-aamylase	α-amylase	β-aamylase	α-amylase	β-aamylase	α-amylase	β-aamylase	α-amylase	β-aamylase
Without nitrogen application	2.3	21.8	11	73	75	115	254	256	481	429
N60	2.5	24.9	14	78	84	131	237	297	555	356
N90	3.0	22.7	15	84	88	109	204	335	586	178
N120	3.6	28.7	22	72	94	100	128	384	592	114
N150	5.1	19.3	26	70	76	111	142	399	613	156
N150+N30 foliage application	3.5	20.4	29	71	76	87	268	247	483	170
N120+N30 foliage application	1.4	26.5	25	67	83	96	249	261	573	96
N150+Albit	4.2	19.3	25	71	70	85	151	388	566	100
N150+Ribav	4.7	20.0	28	68	72	81	267	271	500	206
N150+Epin	4.9	16.9	26	68	75	82	197	310	495	172
N150+Novosil	5.6	21.7	27	70	71	73	253	323	579	129
HCP_{05}	0.6	1.2	3.2	5.1	5.0	6.3	7.6	10.5	7.8	8.7

in wheat was found in the variant with Albit and a small one was found in the variant with Ribav-extra and Novosil in the experiment of 2010.

Amylolytic enzymes affect not only the baking properties, but also the seed quality of grain and the technological properties of malt made of the grain. Therefore, an assessment of aftereffects of nitrogen fertilizers and phytoregulators on the amylase activity in germinating wheat grains was carried out (see Tables 4, 5).

In the variant without nitrogen application and in the variant with nitrogen application in a dose of 60 kg/ha, a pronounced increase of a-and |3-amylase activity in the grain by the 7th day of germination. In variants with higher doses of nitrogen (90-150 kg/ha), the maximum a-amylase activity was observed on the 7th day, and |3-amylase activity - on the 6th day of sprouting.

Grain obtained in variants with high doses of nitrogen had higher α-amylase activity compared to the control, as well as to the variants with late foliar nitrogen fertilization on the 7th day of sprouting. It indicates an improvement of seed grain quality and technological properties of malt, which can be obtained from this grain.

In the experiment in 2010, Albit and Ribav-extra were found to reduce a-amylase activity in the germinating grain, and in the experiment of 2011 all studied phytoregulators appeared to reduce not only a-amylase but also |3-amylase activity in the germinating grain. Consequently, there is a negative effect on the seed grain quality and technological properties of malt.

In variants with different levels of nitrogen nutrition in the sap of leaves (the second leaf from the top of the main shoot of plant), which were selected in the in the phase of formation of the first stem node, the concentration of free amino acids was determined in order to estimate the intensity of synthesis of structurally and functionally active proteins during plant growth and development. It was previously shown that low levels of nitrogen nutrition of wheat reduce the protein synthesis rate and weaken growth processes. It results in the increase of free amino acid concentration in the leaf sap. Increased nitrogen nutrition alters the course of these processes turning to the opposite direction, so the concentration of amino acids in the leaf sap reduces [10].

In the experiments carried out within the two years of study (2010-2011), it was stated that when the level of nitrogen nutrition of wheat is increased, a trend towards the reduction of free amino acids concentration in the leaf sap of plants vegetating, in the phase of the first stem node formation takes place. It indicates their being increasingly consumed for the purposes of protein synthesis — both structural and functionally active — in the vegetative mass of wheat (see Tables 1, 2).

The presented data show that the change in the amino acid concentration in the leaf sap reflects the level of nitrogen nutrition in wheat. It can be proved by high values of the correlation coefficients of the indicator with the nitrogen dose :

r = -0,99 (2010) r = -0,96 (2011). In addition, it was found out that the concentration of amino acids in the leaf sap is closely correlated with the level of wheat grain productivity, r = -0,96; grain unit, r = -0,91; weight of 1000 grains, r = -0,92; wet gluten content in the grain, r = -0,93; protein common content in the grain, r = -0,98; content of albumins and ready soluble globulins, r = 0,90; globulin content, r = 0,85; gliadins content, r = -0,99, glutenins content, r = -0,97; non-extractable proteins, r = 0,99 (correlation is significant at $r > 0,88$ and the level of 0,95).

Thus, based on the results of research carried out in 2010-2011, it can be noted that increasing doses of nitrogen through presowing application up to 150 kg/ha resulted in the productivity of spring wheat cv. Ivolga increased by 47%-76%, wet gluten content in the grain - by 3.4%-4.3%, proteins - by 4.2%, grain hardness - by 5%—10%, grain unit - by 38-47 g/l, weight of 1000 grains - by 3,9-9,9 g. But at the same time gluten weakening by 5-10 units of gluten deformation index and increasing in a-amylase activity in the mature grain has been observed. Late foliar nitrogen fertilization of wheat by urea enhanced the content proteins in the grain by 0.6%-1.1%, wet gluten content - by 2.6%-3.5% and a decrease in a-amylase activity in the mellow grain to the minimum.

When exposed to high doses of nitrogen applied before sowing, and late foliar nitrogen fertilization the accumulation of gliadin and glutenin in caryopses has increased. They demonstrated a substantial deficit in the content of lysine, tryptophan and methionine, whereas the content of albumins, globulins and non-extractable proteins decreased. The latter are better balanced in terms of the essential amino acid content which resulted in the overall biological value of total grain protein being lower.

Under the conditions of water deficit and high temperature stress during the maturation of wheat grains (2010 experiment), a positive action of the phytoregulator Epin-extra was revealed when it was applied at the heading (ear) stage. It increased the productivity of plants (by 8%) as well as the grain unit and improved rheological properties of gluten (decreasing the gluten deformation index). Under the influence of this phytoregulator these technological parameters also improved in a more favourable 2011. Under the stress of 2010 year, an increase in grain unit and a decrease in a-amylase activity of grains was recorded when Albit had been applied. In 2011, Ribav-extra increased the productivity of wheat, but weakened the gluten (causing an increase in gluten deformation index). In 2010, it decreased the grain hardness and a-amylase activity in the grain. In 2010, Novosil decreased a-amylase activity in the grain and in 2011 it weakened the gluten.

In experiments with wheat seedlings, more pronounced a-amylase activity in the germinating grain in variants with high nitrogen doses was observed. It was an indicator of improving seed grain quality and technological properties of malt, which can be obtained from the grain. It was also identified the Negative aftereffects of phytoregulators studied in experiments on amylase activity in the germinating grain was also identified.

Revealed correlations between the concentration of free amino acids in the leaf sap, nitrogen doses , plant productivity, protein composition and technological parameters of grain indicated that nitrogen nutrition can be diagnosed and the yield and grain quality of soft spring wheat can be predicted on the basis of the identification of free amino acids in the leaf sap.

Conclusions

1. The experiments with spring soft wheat (cv. Ivolga) carried out on sod-podzol medium loamy soil, have revealed that increasing doses of nitrogen up to 150 kg/ha the resulted in the upturn of the following parameters: productivity of plants (by 47%-76%), protein content in the grain (by 4.2%), wet gluten (by 3.4%-4.2%), weight of 1000 grains, indicators of grain hardness and grain unit. However, at the same time, the elasticity of the gluten reduced and activity of a-amylase in the mellow seed increased. It affected technological properties of the grain to a certain extent.

2. When foliar nitrogen fertilization of wheat with urea solution in the phase of the grain formation against presowing application of high doses of nitrogen (120-150 kg/ha) was performed, the protein accumulation in the grain (by 0.6%—1.1%) and wet gluten (by 2.6%-3.5%) increased, while the activity of a-amylase decreased. It improved baking properties of the grain.

3. With an increase in the nitrogen nutrition level for wheat by applying nitrogen before sowing and with late foliar nitrogen fertilization, the accumulation of gliadins and glutenins in the caryopses appeared to increase. These proteins are less balanced in terms of the content of essential amino acids. At the same time, the concentration of albumins, globulins and non-extractable proteins decreased therefore diminishing the total biological value of total grain protein.

4. A positive effect of phytoregulators on the formation of grain quality in spring wheat has been revealed provided they were applied at the heading (ear) stage. Grain unit increased under the influence of Epin-extra, the rheological properties of gluten were improved as well. The phytoregulator Albite increased grain unit and reduced the activity of a-amylase in the grain formed in stressful hydrothermal conditions of 2010.

5. A close correlation between the concentration of free amino acids in the leaf sap of spring soft wheat in the phase of the first stem node formation, and nitrogen doses, level of plants' grain productivity, amount and composition of proteins, technological parameters of the grain has been revealed. It proves the possibility of using this indicator for the diagnosis of nitrogen nutrition and the prediction of yield and quality of wheat.

6. Wheat grain formed in variants with high nitrogen doses had a higher level of a-amylase activity during germination. It improves the seed grain quality and technological properties of malt which can be obtained from this grain. Late foliar nitrogen fertilization in the phase of grain formation and use of such phytoregulators as Albit and Ribav-extra reduce the activity of a-amylase in the germinating grain at the heading stage.

References

1. *Albert E,, JauertR., Zerche S.* Computergestutzle Stickstoffdunggung des winter-getres // Tag.-Ber. / Akad. Land wirtsch.-wiss. DDR, Berlin. 1989. 275 s.

2. *Bebvakin V.M., Starichkova N.I., DorogobedA.A.* Grain quality depending on the variety and conditions of vegetation // Grain Economy. 2003. №. 3. P. 22-24.

3. *Berkutova N.S.* Methods of evaluation and the formation of grain quality. Moscow: Rosagropromizdat, 1991. 206 p.

4. *Braziene Z.* Spring wheat yield and productivity components as affected by nitrogen fertilization and weather conditions // Zemdirbyste / Lietuvos zemes ukio univ. Akademija, 2007. Vol. 94. № 1. P. 89-99.

5. *Dospehov BA.* Methodic of field experiment (with the basics of statistical analysis of research results). Moscow: Agropromizdat, 1985. 351 p.

6. *Friebe A.* Brassinosteroids in induced resistance and induction of tolerances to abiotic stress in plants / eds. A.M. Rimando, O.M. Duke, D.C. Washington // Natural Products for Pest Management, ACS Symp. Ser. 2006. Vol. 927. P. 233-242.

7. *Lichko A.K., Lichko N.M., Novikov N.N.* Agrochemical bases of improving a quality of spring wheat grain in conditions of Central part of Non-chernozem zone // Izvestia TSKHA. 2011. Iss. 5. P. 67-71.

8. *Meleshkina E.P.* Development of system of evaluation of wheat quality for improvement of baking properties of flour: Ph.D. thesis in Engineering Science. Moscow, 2006. 52 p.

9. *Mineev KG., Pcn'lov A.N.* Agrochemical basis of improvement the quality of wheat grain. Moscow: Kolos, 1981. 188 p.

10. *Novikov N.N.* Forming of the yield and quality of baking wheat at growth on sod-podzol medium loamy SOIL // Izvestia of TSKHA. 2010. Iss. 1. P. 59-72.

11. *Novikov N.N., Vovessa B.V.* Forming of the quality of grain of spring soft wheat depending on variety, growth enviromnent and level of nitrogen nutrition // Izvestia TSKHA. 1994. Iss.4. P. 14-29.

12. Plants growth regulators in agriculture / Shapovalova O.A. [et al.]. Moscow: VNIIA, 2009. 60 p.

13. *Pleshkov B.P.* Practical course of plant biochemistry. Moscow: Kolos, 1985. 255 p.

14. Practical course on agrochemistry / Kidin V.V. [et al.]. Moscow: Kolos, 2008. 599 p.

15. *Prusakova L.D., Chizhova S.I.* The role of brassinosteroids in growth of plants stableness and productivity //Agrochemistry. 1996. № 11. P. 137-150.

16. *Strong W.M.* Effect of late application of nitrogen on the yield and protein content of wheat//Australian J. Exp. Agric. Anim. Husb. 1982. Vol. 222. №. 114-115. P. 54-61.

17. *Thompson M.J.* Effect of phytoregulators on spring wheat // Cereal chemistry. 2004. Vol. 8. № 3. P. 112-117.

18. *Zavalin A.A., Saergaliev N.H.* Influence of nitrogen nutrition terms and physiologically active substances on forming of the sixe and quality spring wheat yield // Agrochemistry. 2000. № l.P 67-71.

СОСТАВ БЕЛКОВ И КАЧЕСТВО ЗЕРНА ЯРОВОЙ МЯГКОЙ ПШЕНИЦЫ (*TRITICUM AESTIVUM* L.) В ЗАВИСИМОСТИ ОТ УРОВНЯ АЗОТНОГО ПИТАНИЯ И ПРИМЕНЕНИЯ ФИТОРЕГУЛЯТОРОВ ПРИ ВЫРАЩИВАНИИ НА ДЕРНОВО-ПОДЗОЛИСТОЙ СРЕДНЕСУГЛИНИСТОЙ ПОЧВЕ

Н.Н. Новиков, А.А. Жарихина

(РГАУ-МСХА имени КА. Тимирязева)

Аннотация: в опытах с яровой мягкой пшеницей, проведенных на дерново-подзолистой среднесуглинистой почве, установлено, что при повышении уровня азотного питания пшеницы существенно возрастает продуктивность растений, накопление в зерне клейковинных белков, но увеличивается активность α-амилаз в зрелом зерне и ухудшаются реологические свойства клейковины. Некорневая азотная подкормка пшеницы в фазе начала формирования зерна увеличивает накопление в нем клейковинных белков и снижает активность α-амилаз. Выявлено положительное действие на технологические свойства зерна фиторегуляторов эпин-экстра и альбита и последействие высокого уровня азотного питания на амилазную активность прорастающего зерна.

Ключевые слова: яровая мягкая пшеница, оптимизация азотного питания, фиторегуляторы, качество зерна, состав белков, активность амилаз.

Новиков Николай Николаевич - д. б. н., проф. кафедры агрономической, биологической химии и радиологии РГАУ-МСХА имени К.А. Тимирязева (127550, г. Москва, ул. Тимирязевская, 49; тел.: (499)976-29-71, (499)976-16-60; e-mail: tshanovikov@gmail.com).

Жарихина Анастасия Аркадьевна - аспирант кафедры агрономической, биологической химии и радиологии РГАУ-МСХА имени К.А. Тимирязева (127550, г. Москва, ул. Тимирязевская, 49; тел.: (499) 976-29-71, (499) 976-16-60; e-mail: Alibau1@mail.ru).

Prof. Dr. **Nikolai Nikolaevich Novikov** - Ph.D. in Biological Sciences, professor of the Dept, of Agronomic, Biological Chemistry and Radiology, RSAU-MTAA (ul. Timiryazevskaya, 49 Moscow, 127550; phone: +7 (499) 976-29-71, (499) 976-16-60; e-mail tshanovikov@gmail.com).

Zharikhina Anastasya Arkadyevna - Post-graduate student of the Dept, of Agronomic, Biological Chemistry and Radiology RSAU-MTAA (ul. Timiryazevskaya, 49 Moscow, 127550; phone: +7 (499) 976-29-71, (499) 976-16-60; e-mail: Alibaul@mail.ru).