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Influence of Growth Regulators and Macroelements on Dynamic Pattern of Nitrogen and Protein Content in Wheat Grain.

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ABSTRACT

It has been established that plant growth regulators and mineral fertilizers have a positive influence on dynamics of nitrogen in crops of spring and winter wheat. The studies have shown that when plants were treated with growth regulators and with the use of mineral fertilizers there was an increase of protein content in the grain of studied crops.

Keywords: winter wheat, spring wheat, growth regulators, mineral fertilizers, nitrogen, protein

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INTRODUCTION

In the life of plants mineral nutrition is one of the fundamental physiological processes. The main indicator of the plant growing produce quality is the accumulation of nutrients in grain that substantially depends on the mineral elements content in the soil. Influence of mineral nutrition elements in different growth phases and development is determined by the fact that they have a positive effect on physiological, biochemical processes on a plant organism. In the course of plant ontogenesis the character and intensity of metabolic processes undergo essential changes taking into account certain requirements of plants to the environment conditions characteristic of separate growth phases and development stages [11]. At the same time the greatest negative impact on the yielding capacity is made by a deficiency of macro - and microelements, arising in critical growth phases and development of a plant [4].

The elements of mineral nutrition to a degree of their accessibility to vegetating plants can be divided into three groups: insoluble (unavailable elements), soluble (potentially available elements) and elements of soil solution (really available elements). It is inadmissible to liken the quantity of mineral nutrition elements found by means of a chemical analysis of the soil with their quantity really available to a plant. It is necessary to understand by a really available supply of a nutrition element its maximum quantity which can be absorbed by a definite crop for the entire period of its vegetation [1]. An increase of coefficients of nutrition elements use can be reached as a result of accumulation of physiologically reasonable quantity of the elements in organs of plants where they are used in biochemical reactions of cells and this provides growth intensity and increase of yielding capacity of plants. The use of micro fertilizers and growth regulators is one of the ways of an uptake intensification of basic nutrition elements [3, 8, 10].

There was a fact of plant biomass increase and productivity owing to intensification of mineral nutrition. In the process of mineral nutrition one of the most important and bright features of plants is manifested– their autotrophy, i.e. ability to form the organs and tissues from inorganic substances. The plant organism at different stages of growth and development uses nutrients with various intensity. An increase in the amount of phytohormones in the cells of a higher plant promotes the fastest absorption and digestion of mineral substances from the soil [12].

At present an increase of grain production is the main goal of the plant growing branch which can be solved by means of adaptability of field crops to various weather conditions, biologization of land resources and use of resource-saving technologies with optimization of mineral nutrition of a plant. Pre-sowing treatment of seeds and top dressing of plants with the stimulating preparations are referred to resource-saving technologies of grain crop cultivation which provide a positive effect in the root nutrition intensification *[5-7].*

OBJECTS AND INVESTIGATION METHODS

The studies were conducted on the experimental field of FSBEI the Ulyanovsk State Agricultural Academy in 2010 … 2012 - (1 stage). The objects of studying - spring wheat of the variety “Zemlyachka”, winter wheat of the variety “Biryuza”. The experimental design: control (raw seeds), Kresacin, Energy, Albite, Humi, Zircon, Extrasol. In 2011 - 2015 – (the 2nd stage).The design of the experiment: growth regulators - Albite, Tsetsetse, Energy, and also mineral fertilizers diammophoska N15P15K15, diammophoskaN15P15K15S10, TerraflexN17 P17 K17. The area of the plot – 20 sq.m, the experiment replication- quadruple, the plot lay-out - randomized. The soil of the experimental field – leached black soil, medium, average clay loam with the following characteristics: the humus content - 4,3%, mobile compounds of phosphorus and potassium (according to Chirikov) 193 and 152 mg/kg of the soil respectively, the content of mobile sulfur - 4,7 mg/kg of the soil, salt extract pH - 5,3. The applied agrotechnology in the experiment on variants - traditional– standard, the predecessor – complete fallow. Weather conditions for the years of studies were various on temperature conditions and moisture content of the soil that enabled to study the action of the used factors comprehensively. The content of nitrogen was determined in plant samples (State standard specification 134916.4-93).

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RESULTS AND THEIR DISCUSSION

Nitrogen is the most important of nutrition elements for plants as it is an indispensable component of all protein molecules, amino acids, nucleinic acids, chlorophyll, alkaloids, glucosides, many vitamins, biologically active compounds, enzymes which finally make up a biochemical basis of protoplasm. It is in this element that the plants suffer the most acute shortage. The lack of nitrogen in nutrition leads to weakening or termination of life activity processes of the whole plant organism. At earlier stages of crop development it is necessary to create the assimilating surface therefore plants need an intensive nitric nutrition most of all[9].

The studies show that the maximum content of nitrogen in spring wheat leaves is observed in the tillering phase and is from 3,0 to 3,27%, depending on the experiment variant. High nitrogen fixation in this growth and development phase is explained by the fact that plants during this period need a large amount of protein to form tissues (fig. 1). The largest nitrogen content in spring wheat leaves during ontogenesis has been established in variants of Kresacin and Energy. For the years of studies nitrogen accumulation increase has averaged from 0,13 to 0,30%. The maximum content of nitrogen in leaves of winter wheat was observed in the shooting and tillering phase and was from 2,88 to 3,73%, depending on the experiment variant and growth and development phase of plants (tab. 1). The greatest accumulation of nitrogen in leaves of winter wheat during ontogenesis of plants for the years of research was observed on variants of Terraflex and Tsetsetse, notably both against a natural, and fertilized background. Results have shown that the increase of nitrogen in leaves from the used factors was from 0,12 to 0,24% - against a background without fertilizers, from 0,06 to 0,29% - against a background with NPK, depending on the experiment variant. The maximum accumulation of this element in winter wheat leaves during ontogenesis was promoted by the application of sulfur-containing mineral fertilizers. So the maximum accumulation of this element has been reached with application of the preparations Terraflex and Tsetsetse together with sulfur-containing mineral fertilizers that has been 3,97 – 3,88%, respectively. With the subsequent growth and development phases a decrease in the accumulation of nitrogenous compounds takes place in the leaves of the studied crops, reaching a minimum in the phase of milky ripeness. This occurs due to their intensive outflow in reproductive organs that is very important when a complete high-protein grain is formed.

The amount of nitrogen in the stems of spring and winter wheat is similar to the leaves, that gradually decreases with the onset of subsequent phenophases of growth and development (fig. 2, tab. 1). Minimum content of nitrogen in the stems of spring wheat occurred in the phase of milky ripeness. In plants of winter wheat the maximum quantity was noted in variants Tsetsetse and Terraflex and was from 0,1 to 0,29%. Minimum content of nitrogen, both in leaves, and in stems was noted in the phase of milky ripeness of winter wheat.

Nitrogen content in the reproductive organs of grain crops also increased under the influence of growth regulators and mineral fertilizers. The maximum increase of nitrogen in plants of spring wheat has been established in variants Kresacin and Energy and is 0,24% and 0,27% respectively (fig. 3). Nitrogen content in end products of winter wheat also increased under the influence of growth regulators and mineral fertilizers (tab. 1). The largest nitrogen content provided the use of preparations Tsetsetse and Terraflex, 2,61 - 2,72% - against natural fertility, 2,79 – 2,85% – against NPK, 2,82 – 3,01% - against NPK+S, respectively. The outflow of nitrogenous compounds from vegetative organs does not coincide with its incoming in generative ones. It should be noted that during the spring and winter wheat maturation about 20 - 25% of the absorbed nitrogen, potassium up to 35%, sodium about 38% get lost. These losses happen owing to the movement of nutrients into the root system by the end of maturation that finally remains in the fallen leaves, etc.

Positive correlation relationship of spring wheat productivity with the content of nitrogen has been established: in leaves – in the tillering phase (D=89,8%, r=0,94), in stems – in the shooting stage, ear formation (D=98,8%, R=0,99), in ears – in the phase of ear formation, milky ripeness (D=97,7%, R = 0,98). Positive correlation relationship between productivity of winter wheat and nitrogen content has also been established: in leaves - in the phase of tillering (R=0,886); in stems – in the phase of milky ripeness (R=0,818); in ears – in the phase of ear formation (R=0,893). Intensive outflow of nitrogenous compounds from leafy mass in generative organs of spring wheat under the influence of growth regulators creates prerequisites for the greatest protein content in grain. The correlation – regression analysis shows a positive relationship between protein in grain and the content of nitrogen in spring wheat plants: in leaves – in the phase of

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tillering(D=61,9%, r=0,78), in stems – in the ear formation phase (D=81,6%, r=0,90), in ears – in the phase of milky ripeness (D=81,6%, r=0,90).

Quality of grain is a set of biological, physical and chemical and technological properties of grain which determine its suitability and ability to satisfy certain requirements according to the purpose. Quality of grain is a factor of an intensification of agricultural production therefore improvement of biochemical indicators of quality of grain has a key value in the plant growing branch. Positive influence of growth regulators was noted by many authors in the studies [2].

Protein content is one of the most important indicators of grain quality which determines its technological properties in many respects. Protein is a difficult complex of high-molecular organic compounds in which the elementary composition about 53% of carbon, 17% of nitrogen, 7% of hydrogen. The greater portion of proteins in a grain is in the endosperm, and notably in a solid form, as a reserve matter that makes them more resistant to chemical and physical impacts.

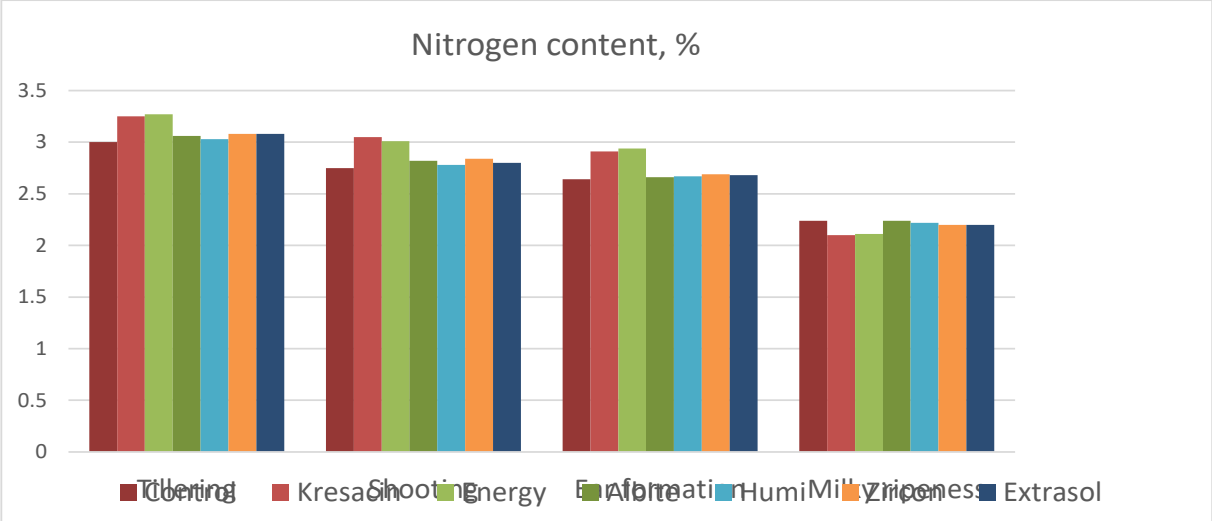

Figure 1: Influence of growth regulators on a dynamic pattern of nitrogen in spring wheat leaves, in % on absolute dry matter (on average for 2010-2012)

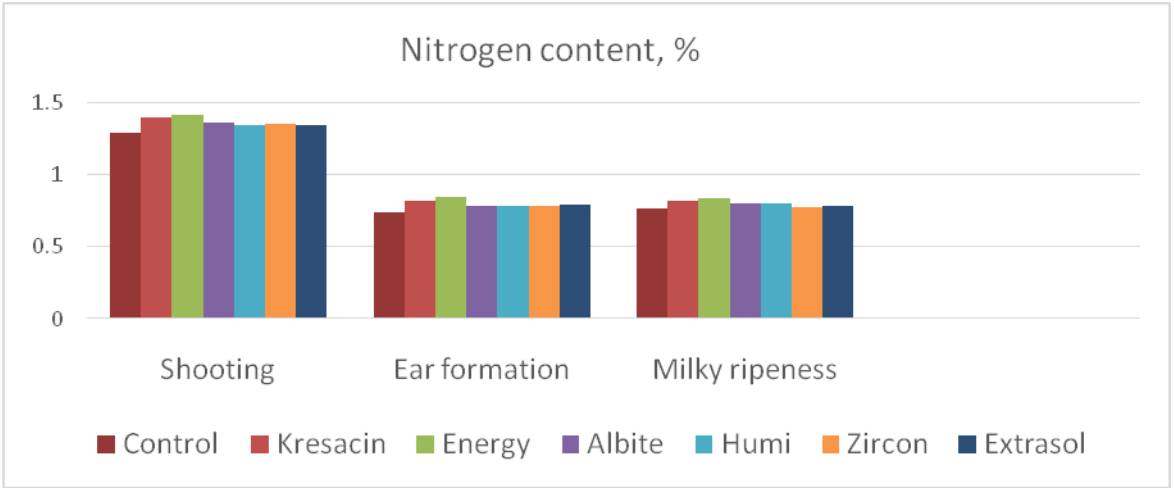

Figure 2: Influence of growth regulators on dynamic pattern of nitrogen in spring wheat stems, in % on absolute dry matter (on average for 2010-2012)

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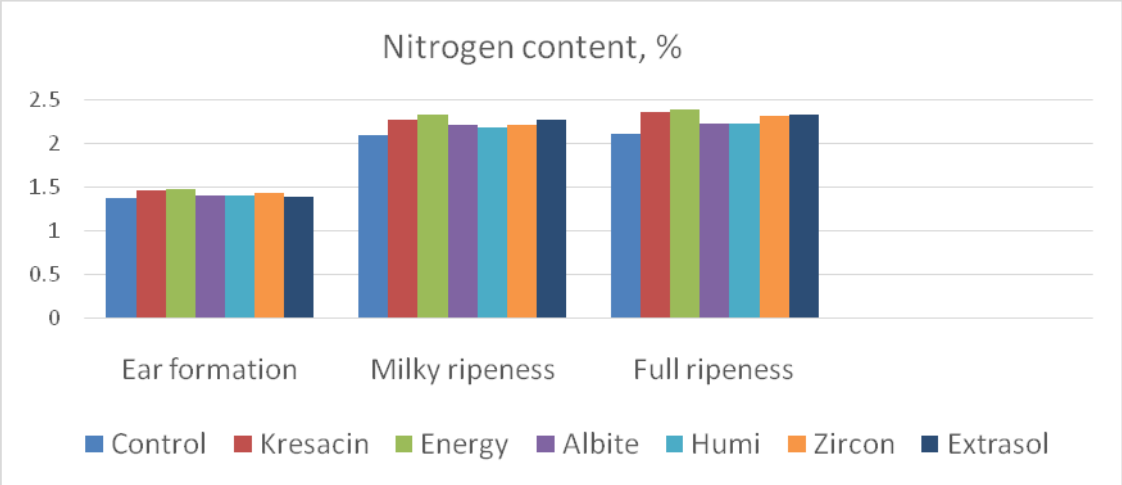

Figure 3: Influenceofgrowthregulatorsondynamicpatternofnitrogeninspringwheatears, in % on absolute dry matter (on average for 2010-2012)

Table 1: Influence of growth regulators and mineral fertilizers on dynamic pattern of nitrogen in organs of winter wheat, in % on absolute dry matter (average for 2011-2015)

Variant	Sproutin g	Tillering	Shooting		Ear formation			Milky ripeness			Grain
		leaves	leaves	stem	leaves	stem	ear	leaves	stem	ear	
Control	3,59	3,01	2,78	1,16	2,10	0,70	1,31	1,92	0,94	2,02	2,38
Albite	3,73	3,14	2,95	1,23	2,23	0,76	1,36	1,81	1,02	2,14	2,52
Tsetsetse	3,78	3,20	3,06	1,26	2,29	0,79	1,39	1,79	1,03	2,19	2,61
Energy	3,69	3,10	2,88	1,21	2,16	0,75	1,35	1,80	1,02	2,11	2,47
Terraflex	3,80	3,28	3,11	1,30	2,32	0,82	1,41	1,79	1,03	2,21	2,72
Control+ NPK	3,65	3,11	2,88	1,25	2,19	0,76	1,36	1,90	0,99	2,15	2,54
Albite+ NPK	3,77	3,22	3,01	1,32	2,31	0,82	1,42	1,81	1,04	2,25	2,75
Tsetsetse+ NPK	3,83	3,28	3,10	1,35	2,35	0,86	1,44	1,83	1,08	2,33	2,79
Energy+ NPK	3,75	3,19	2,96	1,31	2,26	0,82	1,42	1,81	1,02	2,23	2,71
Terraflex+ NPK	3,86	3,33	3,15	1,38	2,38	0,89	1,48	1,87	1,11	2,37	2,85
Control+ NPKS	3,73	3,20	2,97	1,31	2,25	0,82	1,42	1,85	1,06	2,22	2,62
Albite+ NPKS	3,82	3,29	3,09	1,36	2,33	0,86	1,47	1,79	1,10	2,32	2,83
Tsetsetse+ NPKS	3,88	3,37	3,18	1,40	2,41	0,93	1,52	1,76	1,13	2,38	2,82
Energy+ NPKS	3,80	3,28	3,06	1,35	2,32	0,85	1,45	1,78	1,08	2,30	2,73
Terraflex+ NPKS	3,97	3,43	3,24	1,45	2,47	0,99	1,57	1,75	1,17	2,43	3,01

It is very important that the protein composition especially the content of so-called irreplaceable amino acids in it, corresponded to the requirements of a human body or an animal. Deficiency of any major amino acid leads to the fact that for protein synthesis the organism of an animal uses only a part of vegetable amino acids, the others are cleared or are a power source.

The quantity and quality of protein in a plant depends on many factors, and as researches have shown, weather conditions of the vegetative period, especially during the grain filling are of great importance. In the conducted studies under the influence of growth regulators, protein content in the grain of spring wheat increased by 0,13 … 2,13%, depending on the variant, the greatest increase being observed in variants Kresacin and Energy (tab. 2).

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Table 2: Protein content in spring wheat grain of the variety Zemlyachka, % (for 2010-2013)

Variant	2010	2011	2012	2013	Average for 2010 - 2013
Control	10,87	14,10	11,07	11,33	11,84
Kresacin	12,20	14,87	13,03	12,10	13,05
Energy	12,13	15,40	13,20	12,53	13,32
Albite	11,00	14,47	12,43	12,40	12,58
Humi	11,31	14,37	12,33	12,10	12,53
Zircon	12,27	14,33	12,93	12,20	12,93
Extrasol	11,60	15,17	13,07	12,30	13,03
LSD 05	0,28	0,52	0,55	0,61	–

Research results (fig. 4) demonstrate that the used preparations promoted the improvement of quality indicators of winter wheat grain. At the same time protein content varied by years depending on the variant from 13,6% to 18,2%. The use of growth regulators against natural fertility promoted an increase in this indicator by 6,5% - 12% in comparison with control. The greatest protein content was in Tsetsetse NPKS variants (17,54%) and Terraflex NPKS – 18,2%.

Under the influence of growth regulators and mineral fertilizers the protein content in winter wheat grain increased by 0,5 – 1,9% against natural fertility of the soil, for 0,97 – 1,77% – against NPK, for 0,63 – 2,23% – against NPKS. The greatest protein content was noted on variants Tsetsetse NPKS and Terraflex NPKS.

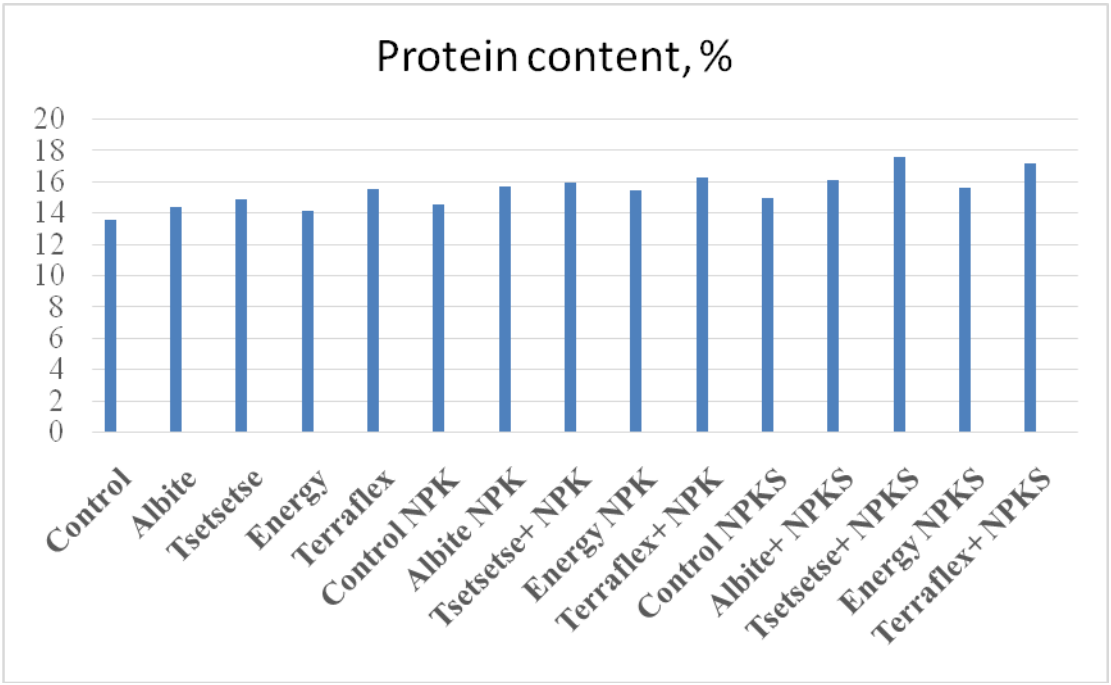

Figure 4: Protein content in winter wheat grain depending on the application of growth regulators and mineral fertilizers (average for 2011 – 2015)

CONCLUSIONS

Thus, the balanced mineral nutrition is a key factor of formation of highcropyields. Growth regulators and mineral fertilizers used by us have a significant positive effect on a supply of plants of the studied crop with mineral nutrition elements. It is explained by their stimulation of all metabolic processes in plants at all stages of their growth and development. The combination of the studied factors provided a higher level of mineral nutrition of plants during the whole vegetative period, which provided a basis for a fuller use of genetic potential of productivity in the studied crops.

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