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# BORON CONTENT IN WINTER WHEAT CROWN ON PODZOLIZED CHERNOZEM

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*In the podzolized chernozem where fertilizers were not applied for a long time, high content of mobile compounds of boron is formed. In winter wheat plants, grown on podzolized chernozem without fertilization, boron deficiency is formed. It should be associated with expanded ratio of boron to calcium in plant samples. For an objective estimation of boron supply in plants of winter wheat we should not restrict ourselves only with the definition of soil provision with mobile boron. You should also determine the content of boron and calcium compounds in plant materials.*

Boron does not occur in its free state in nature. In soil it is in the shape of the molecule $H_3BO_3$ (by pH – 5–9) or anion $B(OH)_4$ (by pH >9,2) [1]. Also the soil type, moisture, content of organic matter can affect the availability of boron [2]. In particular, the increase of physical clay content leads to the increase of available boron content [3, 4].

The average content of boron in plants is 0.0001%. The ability of boron to create complex compounds with simple sugars, polysaccharides, alcohols, phenolic compounds etc. is of great importance for the implementation of its biological function [5]. Possible functions of boron include its influence on sugar transport, synthesis of cell walls, lignification, indol acetic acid metabolism and others [6]. Boron is sometimes referred to mezoelements because for the vital functions of some plants, it must be much more than the other elements [7]. The need for boron is different for different cultures. Dicotyledonous plants absorb about 10 times more boron than monocotyledonous. Different cultures have different tolerance to the lack of boron. For example sunflower is very sensitive, maize is moderately sensitive and wheat is tolerant to a lack of boron [8]. Drought during the period of phenological phases of plants critical to boron contributes to the deficiency of available boron in soil solution even in soils with its sufficient supply. For the majority of boron fill crops boron is a critical micro-element by high-intensity growing technologies [9]. In general in the estimation of specialists of Food and Agriculture Organization of UNO boron deficiency is one of the main plant growing limitations in the world. It is believed that on a global basis boron deficiency is the second most important mikro-food constraint for agricultural crops after zinc [10].

The aim of our study was to investigate the provision of boron of winter wheat plants grown on podzolized chernozem of the Forest Steppe of Ukraine.

**Research Methodology**. The investigation was conducted at the experimental field of the Department of Agricultural Chemistry and Soil Science of Uman National University of Horticulture on the plots, where fertilizers were not applied during the last 48 years. The soil of the research field is podzolized heavy loam chernozem on loess. Physical-chemical properties of the soil are the following: exchange acidity (($pH_{KCl}$)) - 5,3, hydrolitic acidity - 3,32 cmol/kg, total exchangeable bases - 28,4 cmol/kg, base exchange capacity - 34,7 cmol/kg, degree of saturation of soil by bases – 82,%. Soil properties and topography of the research field correspond to soil varieties of moderately continental Eastern European facies, within which the obtained results can be spread.

In our research we made the extraction of mobile forms of boron from soil with 0.2 N hydrochloric acid solution [11, 12]. Soil samples were taken from the layer 0-20 cm. Samples of winter wheat vegetative plants were taken in the earing phase. The grain of wheat was taken at dead-ripe stage. Prepared samples of plant materials and soil extracts were studied by atomic emission spectrometer with inductively coupled plasma Shimadzu Multitype ICP Emission Spectrometer

**Results of the research**. Boron is wide-spread in nature with an average concentration of about 10 mg/kg in the earth's crust (range: from 5 mg/kg in basalts to 100 mg/kg in slates) and about 4.5 mg/l in ocean [13]. Concentration of total boron in soils is from 20 to 200 mg/kg [14]. Its concentrations, available for plants, also differ in soils, but they are usually less than 5-10% of the gross content [15].

Boron belongs to the second class toxicity substances [16]. However, specific toxic levels of boron in the soil, both gross and mobile, are not established by hygienic standards for a person [17]. There is not much information concerning optimal content of boron in human diet. However it is observed that its average daily intake is approximately 1.5 mg/day for an adult. According to the European Office of Food Safety maximum permissible dose of boron use is 10 mg/person/day for adults [18].

Facts of boron toxicity for plants are relatively rare compared to boron deficiency. It is a unique element because it has a very narrow range between deficient and toxic levels in soils - <0.5 mg/kg and> 5 mg/kg respectively. [19] While the modern experimental data are insufficient to accurate determination of toxic levels of boron, it is assumed that the content of mobile boron 5.8 mg/kg of soil may be unsuitable for some species of plants [10]. According to Australian researchers there are cases of boron toxicity mainly confined to the low rainfall (<550 mm/year) in soils are poorly leached and have a concentration of mobile boron> 12 mg/kg soil. In this case testing of soil for mobile boron content is considered by certain scholars to be the best method for determining the availability of plants with boron. It is believed that testing plant tissues are less reliable, as its critical limits can not be easily identified by the uneven accumulation of boron in plant tissues, changes in the absorption of boron at different stages of growth and leaching of boron from plant tissue in precipitation [8].

Some scientists have noted that the optimal level of mobile boron in soil is 3 mg/kg [21]. In general, it is believed that for most crops 1-4 mg/kg of soil of mobile boron is enough to prevent its deficiency [22]. Content less than 0.5-1 mg/kg is considered to be insufficient [23].

A number of gradations on the content of mobile boron in the soil were developed. American and Canadian scientists consider the soil to be medium provided with boron when its content is in range of 0.6-0.8 mg/kg soil, soil with the content of mobile boron more than 2 mg/kg is considered to be well provided [24, 25]. Other researchers believe that the content of mobile boron less than 0.40 mg/kg is low, 0,5-1,20 mg/kg - optimal, and more than 1.20 mg/kg - high [12]. According to the gradation existing in the Republic of Belarus the content of mobile boron (mg/kg) < 0,30 is low; 0,31-0,70 - medium; 0,71-1,0 - high,> 1.0 - very high [26]. In Russia they distinguish soil by mobile boron content (mg/kg): <0.2 - very low; 0.2-0.4 - low; 0.4-0.8 - medium; 0.8-1.2 - high:> 1.2 - very high [27]. However, it is noted that even with sufficient levels of mobile boron content in soil under certain conditions, plants can feel its deficiency [28].

Under the conditions of our experiment of mobile boron content in the arable layer soil ranged from 1,89-3,15 mg/kg, what according to most gradations means high provision of soil with this element.

There is a certain optimum concentration of boron in selected organs and tissues for each plant species to ensure normal conditions for the processes of life. Polish researchers have obtained higher yields of wheat, when the concentration of boron in shoots varied between 1,9-2,4 mg/kg [29]. In the investigations of Turkish scientists S. Irmakta H. Vapur with increasing standards of boric fertilizers it was found that increasing standards of boric fertilizers contributed to the increase of boron content in the leaves of wheat samples from 1.62 to 18.73 mg/kg and boron content in the grain of wheat samples was from 2.6 to 9.1 mg/kg [23]. Summarizing a number of studies on the application of boron fertilizer on wheat, A. Rashid, S. Muhammad, and E. Rafique assert that the boron content in wheat plants <6 mg/kg is low, 6-10 mg/kg - optimal, and> 10 mg/kg - high [12]. It is confirmed by B.S. Dear, R.G. Weirta H.J. Farr [28, 30]. AC. Gupta thinks that the boron content in the green wheat mass> 16 mg/kg is toxic [31]. However, V. Tserlyng argues that the optimal content of boron in plants of wheat in booting stage is when it is in the range 2,1-8,0 mg/kg, and in the upper leaves - of 8-10 mg/kg [32].

In our experiment, the content of boron in vegetative plants of winter wheat in booting stage was 1.6 mg/kg of dry weight (Table). Based on gradation of provision, according to the content of boron in vegetative plants of winter wheat it could be argued that such content of boron compounds is low.

**Content of boron and calcium in winter wheat, mg/kg of dry matter**

| Object of analyses: | Chemical element: | |
|---|---|---|
| | B | Ca |
| Vegetative wheat | 1,6 | 1515,0 |
| Grain | 0,3 | 284,4 |

The content of mobile boron in the soil of test plots is high. This discrepancy can be explained by a large number of mobile calcium in soil, which is an antagonist of boron.

R.P.S. Chauhan and A.K. Asthana suggest using the ratio of calcium content to boron content in the green mass of plants as an indicator of their provision with boron [33]. This is connected with the antagonism between these two elements. Narrowing the ratio Ca:B involves the improving of plant provision with boron [34]. Several researchers observe that even when the plants get enough of mobile boron, the excessive amount of calcium in the tissues can lead to boron deficiency. Due to the calculations of U.C. Gupta the ratio in vegetative wheat plants Ca/B> 697 cause boron deficiency and ratio 7-22 shows the toxic level of boron [35-37]. Under the conditions of our experiment in the green mass of winter wheat at earing stage ratio Ca/B was 946, what indicates the creation of conditions of boron deficiency in plants.

It is believed that the optimal content of boron in wheat grain is 1.5 mg/kg and calcium - 800 mg/kg [35]. Scientists in the Forest Steppe zone received boron content in wheat grain within 0,8-3 mg/kg [38]. In our experiments in the grain of winter wheat it was found 0.3 mg/kg of boron. This is considerably less than shown in scientific sources, which is an additional proof that the boron deficiency is formed in winter wheat plants.

**Conclusions**. In the podzolized chernozem where fertilizers were not applied for a long time, high content of mobile compounds of boron is formed.

In winter wheat plants, grown on podzolized chernozem without fertilization, boron deficiency is formed. It should be associated with expanded ratio of boron to calcium in plant samples.

For an objective estimation of boron supply in plants of winter wheat we should not restrict ourselves only with the definition of soil provision with mobile boron. You should also determine the content of boron and calcium compounds in plant materials.

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