

## **NITROGEN REMOVAL ASSESSMENT IN OMITTED PLOT TRIALS WITH WHEAT AND BARLEY**

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### **Abstract**

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Nutrients removal by crops is one of the key indicators to determine the optimal nutrient status. During the period 2009 – 2012 in the region of Pomorie and village Sadievo (municipality Nova Zagora), a Eutric Vertisol and Chromic Luvisols, it was assessed the influence of the nutrition conditions on the nitrogen removal by winter wheat (variety „Aglika”) and winter barley (variety „Aheloy“). Eight nutrition treatments were studied during the field experiment, including addition and omission of nutrients – untreated control; N; P; K; NP; NK; PK and NPK. Yield parameters and chemical composition of the main and secondary production were reported every season to determine the efficiency indicators and nitrogen removal per harvested area and per yield unit (grain). Analysis of the data for both sites of the research, shows that alone phosphorus addition and potassium addition, as well as nitrogen omission (PK) led to lower nitrogen removal per ton of wheat production compared to conditions with balanced nutrition (NPK). The highest nitrogen removal per ton of barley production was reported under conditions of single addition of nitrogen for the region of Pomorie, and the village Sadievo. Nitrogen removal for one tone production of wheat and barley was variable depending on the specific conditions of the experimental regions and nutrition conditions. The differences were relatively small and in average nitrogen removal for one tone production wheat was higher in the region of Pomorie – 24.4 kg t<sup>-1</sup> compare to 22.5 kg t<sup>-1</sup> in the region of Sadievo. For barley, nitrogen removal was higher in Sadievo – 22.2 kg t<sup>-1</sup> compare to 21.6 kg t<sup>-1</sup> for the region of Pomorie. For both crops at the two regions of the study, the highest nitrogen removal for one tone production was reported under conditions of single addition of the nitrogen. The similar results for nitrogen removal for one tone of wheat and barley grain obtained under optimal nutrient conditions NPK showed the possibility of using universal data for the nitrogen removal in different regions.

*Key words:* nitrogen removal; wheat fertilization; barley fertilization; nutrient addition and omission

### **Introduction**

Plants have a fundamental dependence on inorganic nitrogen and 85–90 million metric tons of nitrogenous fertilizers are added to the soil worldwide annually (Good et al., 2004). According to many Bulgarian authors, for efficient crop production is important to reduce the nutrient expense for unit crop yield. (Stanchev, 1990; Angelova and Hristov, 2003; Tomov, 2004; Dimova et al., 2005; Ivanova et al.,

2007; Tomov et al., 2008; Tomov et al., 2008; Ivanova et al., 2010; Kostadinova et al., 2010; Yancheva et al., 2013; Landjeva et al., 2014; Tsenov et al., 2014) This parameter is affected by many factors and for managing sustainable crop nutrition is important to have information about the influence of nutrient interaction. Nitrogen is one of the most expensive nutrients to supply and commercial fertilizers represent the major cost in plant production (Céline Masclaux-Daubresse et al., 2010). Nutrients removal by crops is one of

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the key indicators to determine the optimal nutrient status. It is known that the export of nitrogen, phosphorus and potassium in wheat and barley depending on the magnitude of yield, chemical composition of plants, soil and climatic conditions and many other factors.

To regulate the balance of essential nutrients in agriculture, it is important to be analyzed the indicators of uptake and removal of biologically important elements: nitrogen, phosphorus and potassium in crop yields (Dimitrova and Borisova, 1996). The removal of essential nutrients – nitrogen, potassium and phosphorus for formation of yield of 100 kg grain did not significantly affected by systems of tillage and fertilization (Nikolova et al., 2001). Unlike the nitrogen removal which was influenced by the nutrition conditions, P and K removal was influenced more by the climate conditions, field specifics and yields magnitude and less than the nutrition conditions (Stamenov and Valeva, 2016).

The aim of the study was the nitrogen removal assessment for wheat and barley, grown under the conditions of South-Eastern Bulgaria, depending on the crops nutrition.

## Materials and Methods

The study was conducted during the period 2009 – 2012 in South-Eastern Bulgaria and cover regions with different soil and climatic conditions – Pomorie region and Sadievo, Nova Zagora Municipality. On Eutric Vertisol and Chromic Luvisols, it was assessed the influence of the nutrition conditions on the nitrogen removal by winter wheat variety „Aglika“ and winter barley variety „Aheloy“. The trials were conducted by the method of fractional plots in four replications and size of the test plots – 25 m<sup>2</sup>. Eight nutrition treatments were studied during the field experiment, including addition and omission of nutrients – untreated control; N; P; K; NP; NK; PK and NPK. The nitrogen was applied before the spring vegetation of the crops, while phosphorus and potassium were applied just before the main tillage. The fertilization rates were determined according to the soil nutrient status, crops grown and target yields. The fertilizers used in the experiments were: ammonium nitrate (N-334 g kg<sup>-1</sup>), triple superphosphate (P<sub>2</sub>O<sub>5</sub> – 460 g kg<sup>-1</sup>), potassium chloride (K<sub>2</sub>O – 600 g kg<sup>-1</sup>). Weeds, pest and disease control measures were conducted with proper pesticides, when needed. Yield parameters and chemical composition of the main and secondary production were reported every season to determine the efficiency indicators and nitrogen removal per harvested area and per yield unit (grain). *ANOVA two-way analysis* (Pearson, 1895; Fisher, 1925; Tukey, 1977) *of variance for N-uptake (wheat) and its dependence on the factors fertilization and field conditions* was applied for the statistical data

processing. According to the applied statistical data processing the figures for N – uptake has a normal distribution. This favours their subsequent statistical processing. Factors of fertilization and location affected the N-uptake. The year was not affecting this feature.

## Results and Discussions

The data for N-removal for winter wheat, grown in Pomorie was in the range from 22.00 to 27.48 kg t<sup>-1</sup>, depending from the nutrition conditions (Figure 1).

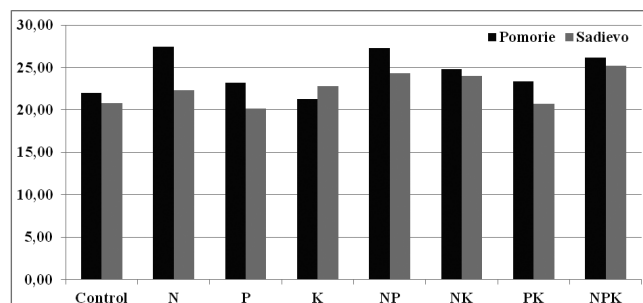


Fig. 1. Nitrogen removal in winter wheat, 2009–2012, kg t<sup>-1</sup>

The highest nitrogen removal per ton of wheat production for Pomorie was reported under conditions of single addition of nitrogen – 27.48 kg t<sup>-1</sup> and omission of potassium (NP) – 27.32 kg t<sup>-1</sup> which led to increased removal of nitrogen by up to 270 g kg<sup>-1</sup> compared to the control. The same trend occurs under balanced nutrition (NPK) – nitrogen removal was up to 190 g kg<sup>-1</sup> compared to the control. The lowest level was under nitrogen omission nutrition (PK), while relatively high was under the nutrition regime where nitrogen was applied alone (N). The lowest level between double combinations was under nitrogen omission nutrition (PK), and it was comparable to nutrition regimes where phosphorus and potassium were applied alone.

N-removal for Sadievo region was significantly lower in comparison with Pomorie (20.18 to 25.17 kg t<sup>-1</sup>). The highest nitrogen removal per ton of winter wheat production for Sadievo region was reported under balanced nutrition (NPK) which led to increased removal of nitrogen by up to 210 g kg<sup>-1</sup> compared to the control. However, high N-removal for Sadievo region was occurred also under phosphorus omission nutrition (NK), as well as under potassium omission nutrition (NP) – nitrogen removal per ton of winter wheat was almost the same – about 24.00 kg t<sup>-1</sup>. The lowest level was under nitrogen omission nutrition (PK), nutrition regime where phosphorus was applied alone (P) and the treatment

without fertilization. N-removal where the nutrient was applied alone and where potassium was applied alone was almost the same – in average 22.5 kg t<sup>-1</sup>.

The highest value of N-uptake was under NPK – 29,1kg / t, followed by NK, N and NP – average value of 26.4kg/t. Regarding the site (location), the lowest values were reported in the Sadievo area – 22.5kg/t.

The data for N-removal for winter barley, grown in Pomorie was in the range from 18.44 to 24.61 kg t<sup>-1</sup>, depending from the nutrition conditions (Figure 2).

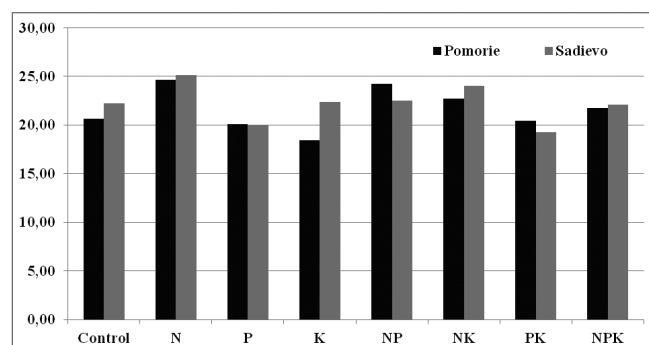


Fig. 2. Nitrogen removal in winter barley, 2009–2012, kg t<sup>-1</sup>

With the highest removal was the nutrition where nitrogen was applied alone (N), which led to increased removal of nitrogen by up to 210 g kg<sup>-1</sup> compared to the control. Under nutrition where nitrogen was applied in combination with phosphorus or potassium, winter barley removed higher level of nitrogen in comparison to the balanced nutrition (NPK).

The lowest level of N-removal for winter barley, grown in Pomorie was under treatment where potassium was applied alone (K) and under nitrogen omission nutrition (PK) – up to 110 g kg<sup>-1</sup> lower level of N-removal in comparison with the control.

In Sadievo, N-removal for winter barley was close to this in Pomorie – 19.24 – 25.09 kg t<sup>-1</sup>. Despite the variations in the different nutrition conditions from the two fields, the trend for N-removal was almost the same – with the highest removal was the treatment where nitrogen was applied alone (N) and nutrition where nitrogen was applied in combination with phosphorus (NP) or potassium (NK).

The lowest level of N-removal for winter barley, grown in Sadievo was under nitrogen omission nutrition (PK) and under nutrition regime where phosphorus was applied alone (P) – up to 130 g kg<sup>-1</sup> lower level of N-removal in comparison with the control.

Average N-removal in the region of Pomorie for winter wheat and winter barley was higher than Sadievo (Figure 3, Figure 4).

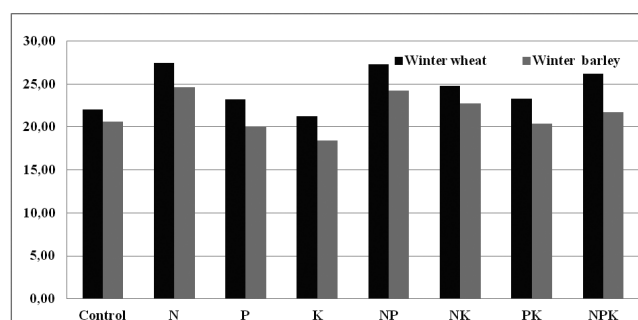


Fig. 3. Nitrogen removal in winter wheat and barley, Pomorie, 2009–2012, kg t<sup>-1</sup>

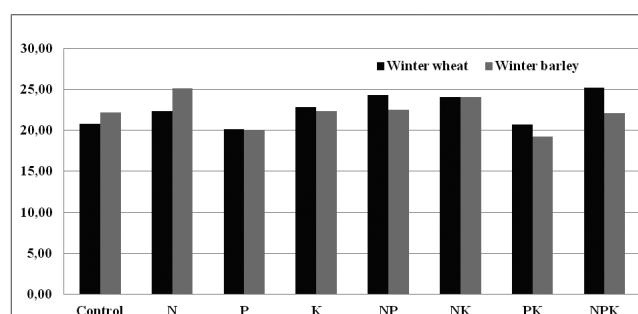


Fig. 4. Nitrogen removal in winter wheat and barley, Sadievo, 2009–2012, kg t<sup>-1</sup>

Nitrogen removal for winter wheat and barley in Pomorie follows similar trends. With the highest N-removal were treatments with nitrogen addition – N, NP, NK and NPK.

For Sadievo region the average N-removal for winter wheat and barley was almost the same.

The differences were not significant, but generally nitrogen removal for one tone production wheat was higher in the region of Pomorie and for barley, nitrogen removal was higher in Sadievo.

For both crops at the two regions of the study, the highest nitrogen removal for one tone production was reported under conditions of single addition of the nitrogen.

## Conclusion

For both sites of the research, single phosphorus addition and potassium addition, as well as nitrogen omission (PK) leads to lower nitrogen removal per ton of wheat production compared to conditions with balanced nutrition (NPK). The highest nitrogen removal per ton of barley production was reported under conditions of single addition of nitrogen for the region of Pomorie and the village Sadievo. For both points, concerning barley, the omission of potassium (NP) and omission of phosphorus (NK) led to increased removal

of nitrogen by up to 110 g kg<sup>-1</sup> compared to conditions with balanced nutrition (NPK). Nitrogen removal for one tone production of wheat and barley was variable depending on the specific conditions of the experimental regions and nutrition conditions. Nitrogen removal for one tone production of wheat was higher in the region of Pomorie and for barley, nitrogen removal was higher in Sadievo. For both crops at the two regions of the study, the highest nitrogen removal for one tone production is reported under conditions of single addition of the nitrogen. The similar results for nitrogen removal for one tone of wheat and barley grain obtained under optimal nutrient conditions NPK showed the possibility of using universal data for the nitrogen removal in different regions.

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