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UPTAKE AND UTILIZATION EFFICIENCY OF NITROGEN AND PHOSPHORUS IN DURUM WHEAT

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Abstract

The uptake and utilization efficiency of nitrogen and phosphorus in durum wheat was studied under conditions of long term fertilizing experiment. The standard variety „Progress”, selected in Institute of field crops – Chirpan town, Bulgaria was grown in two field crops rotation cotton – durum wheat under rain conditions for the period of three vegetations including years 2011 – 2013. The experimental design was the method of Latin square with trial plot size 50m^2 in four replications. The treatments were as follows: N_0P_0; N_0P_{80}; N_0P_{120}; N_0P_{160}; $N_{120}P_{80}$; $N_{120}P_{120}$; $N_{120}P_{160}$. Nitrogen fertilization as NH_4NO_3 was applied early spring. The phosphorus fertilization was applied before sowing as triple superphosphate. The soil type of experimental field was Eutric vertisols. Weather conditions during the studied period 2011 – 2013 were different as a temperature and rainfall each year.
It was established that productivity of aboveground biomass and grain was two-fold higher in fertilizing systems with applied N_{120} and phosphorus rates of 80 - 120 kg P_2O_5.ha^{-1}, compared to the systems with no phosphorus fertilizing. Uptake efficiency of nitrogen and phosphorus or total uptake of these nutrients in aboveground dry mass at maturity, similar to wheat productivity, was higher in systems fertilized with nitrogen. The uptake of nitrogen was in the range 52.5 – 166 kg N.ha^{-1}, and phosphorus uptake – 22.5 - 77.4 kg P_2O_5.ha^{-1}, in average for the period. The highest expense of nitrogen for 100 kg grain formation was established in fertilizing system $N_{120}P_{120}$ – 3.84 kg N. The expense of phosphorus for 100 kg grain formation increased in parallel with applied phosphorus rate and did not depend of nitrogen fertilizing. The highest value was observed in systems with applied high phosphorus rate of $P_{160.}$ Nitrogen utilization efficiency for biomass and grain production in durum wheat was the lowest in fertilizing system $N_{120}P_{120}$, and the lowest phosphorus utilization efficiency was obtained in fertilizing treatment $N_{120}P_{160}$.

Key words: *durum wheat, nitrogen, phosphorus, efficiency*

Introduction

Durum wheat needs nitrogen during all vegetation period. For the formation of 100 kg grain durum wheat uptaked 3.0 – 3.7 kg nitrogen. Nitrogen fertilization should be well balanced with phosphorus and potassium in the soil and provide the necessary amounts to formation of the planned yields, included nitrogen losses (Lalev at. al., 1995).
For the fertilization of durum wheat in the region of Chirpan was established, that for formation of 100 kg grain at fertilization rates from 60 to 180 kg.ha^{-1} was uptaked 3.05 to 4.37 kg N, 1.2 – 1.5 kg P_2O_5 and 1.7 – 2.4 kg K_2O (Panayotova, 2005).
Bauer et al. (1987) indicated, that the various phosphate availability and fertilization affect the percentage of phosphorus in plants and phosphorus uptake with the aboveground biomass. Quantity and quality of durum wheat grain were formed during all vegetation period and depends on the genetics of the variety, agro-ecological conditions and farming technology (Dekov et. al., 1989). Laconde et. al. (1993) indicated that durum wheat averaged demand to

phosphorus, and according to Schulthess et al. (1993) the content of phosphorus was preferably genetics. According to Miller et al. (1994) ripening stage in the grain was concentrated over 78% of total phosphorus.
The aim of this study was to investigate uptake and utilization efficiency of nitrogen and phosphorus in various systems of combined nitrogen-phosphorus fertilization in durum wheat variety Progress.

Materials and methods

The investigation was studied under conditions of long term fertilizing experiment. The standard variety „Progress”, selected in Institute of field crops – Chirpan town, Bulgaria was grown in two field crops rotation cotton – durum wheat under rain conditions for the period of three vegetations including years 2011 – 2013. The experimental design was the method of Latin square with trial plot size $50m^2$ in four replications. The treatments were as follows: N_0P_0; N_0P_{80}; N_0P_{120}; N_0P_{160}; $N_{120}P_{80}$; $N_{120}P_{120}$; $N_{120}P_{160}$. Nitrogen fertilization as NH_4NO_3 was applied early spring. The phosphorus fertilization was applied before sowing as triple superphosphate. The soil type of experimental field was Eutric vertisols.

Results and discussion

In the studied period 2011 - 2013 was established, that least nitrogen was uptaken from the soil with the aboveground biological yield of durum wheat cultivar Progress in the system without fertilization (control variant) – 52.5 $kg.ha^{-1}$. The uptake in the combined nitrogen-phosphorus systems (146.6 – 166.0 $kg.ha^{-1}$) proven exceed more than 2 times those in systems without nitrogen (61.3 – 70.4 $kg.ha^{-1}$). The uptake of nitrogen increased to fertilization rates $N_{120}P_{120}$ – 166.0 $kg.ha^{-1}$, and then in the high phosphoric rate 160 $kg.ha^{-1}$ in cultivar Progress nitrogen uptake decreased by 13%, indicated that phosphorus affect positive for rational use of nitrogen by plants. The difference in uptake between combined nitrogen fertilization systems was not proven. (Fig. 1).
The phosphorus uptake for the vegetation period depends on the concentration of the element and formed biomass. It was established, that least phosphorus was uptaken from the soil with the aboveground biological yield of durum wheat cultivar Progress in the control variant (without fertilization) – 22.5 $kg.ha^{-1}$. In combined nitrogen-phosphorus fertilization the uptake values was (68.7 – 77.4 $kg.ha^{-1}$), as proven almost twice exceeds those in the systems with alone phosphorus fertilization (34.7 – 39.5 $kg.ha^{-1}$), which indicated that inclusion of nitrogen in the fertilization system increased the amount of uptaken phosphorus of durum wheat. The phosphorus uptake increased with increasing phosphorus rate and was highest in fertilization system $N_{120}P_{160}$ – 77.4 $kg.ha^{-1}$, but the difference between the combined nitrogen-phosphorus fertilization systems was unproved (Fig. 2).
The expense of nutrients, i.e. kilograms active substance nitrogen (N) and phosphorus (P_2O_5) to formation of 100 kg main production of wheat grain was usually within the range 2,5 - 3,5 kg N; 0,8 - 1,5 kg P_2O_5 (Gorbanov, 2010; Nikolova and Yordanova, 2000), which corresponds with the results of the present study.
The average results for three-year experimental period indicated, that the expense of nitrogen to formation of 100 kg durum wheat grain in the fertilization systems was proven highest in the combined fertilization $N_{120}P_{120}$ - 3,84 kg and exceeded those of the high phosphorous rate 180 $kg.ha^{-1}$combined with N_{120} by 7%, and the difference with the control variant was 37% (Fig. 3).

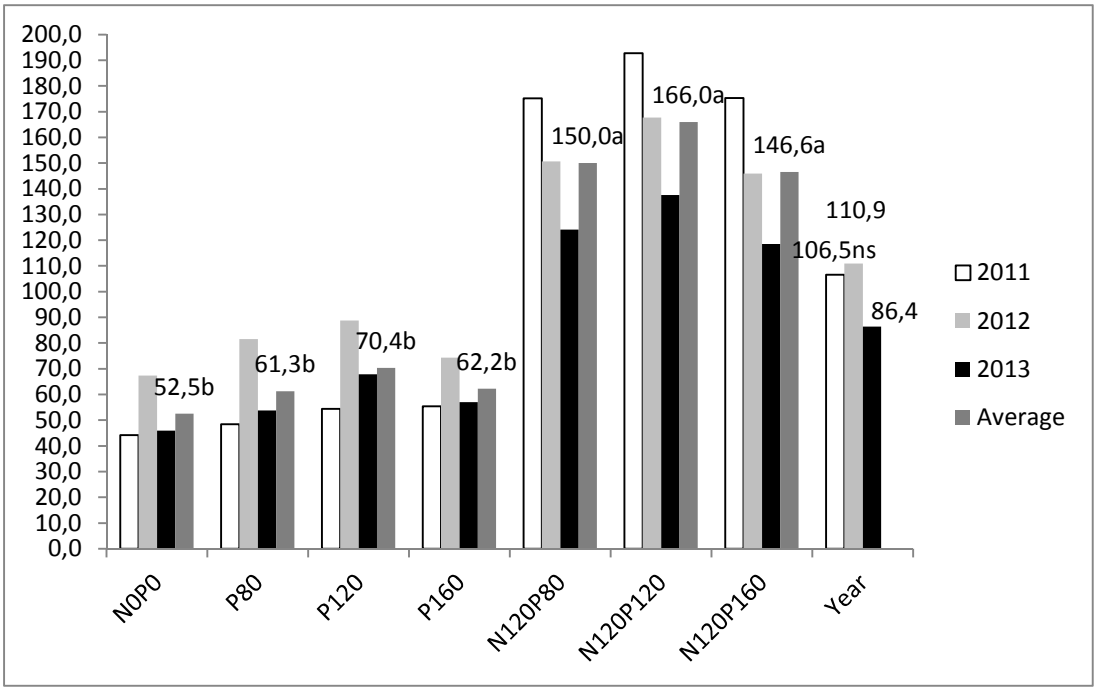

Figure 1. Nitrogen uptake in grain+straw (kg.ha^{-1}) in cultivar Progress depends on the fertilization system

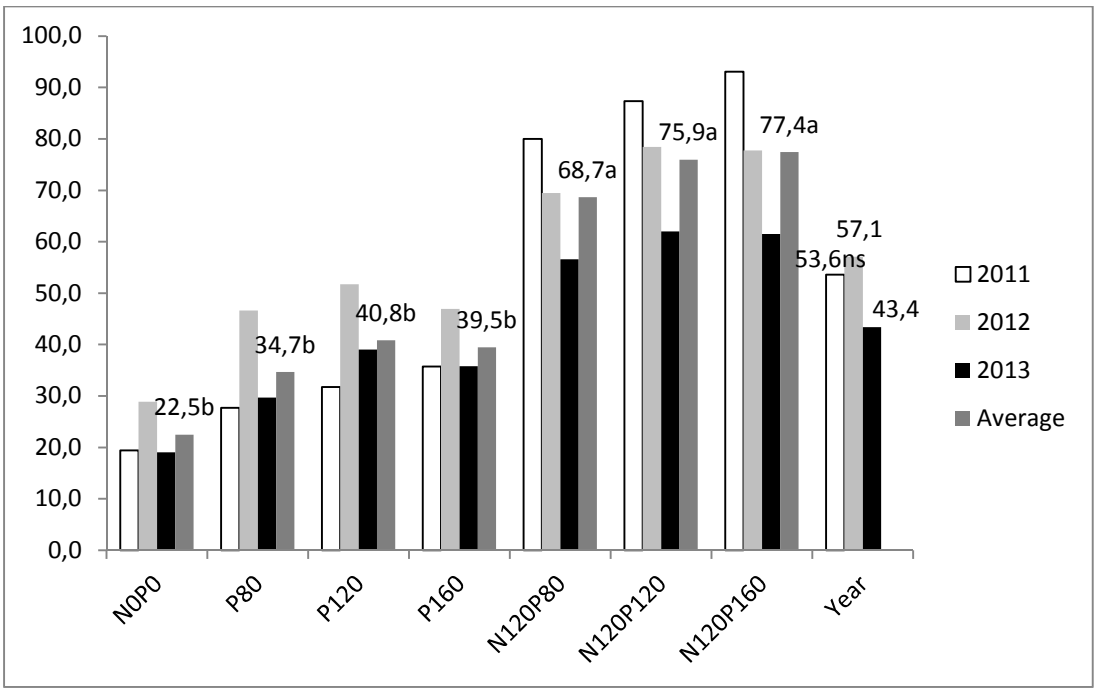

Figure 2. Phosphorus uptake in grain+straw (kg.ha^{-1}) in cultivar Progress depends on the fertilization system

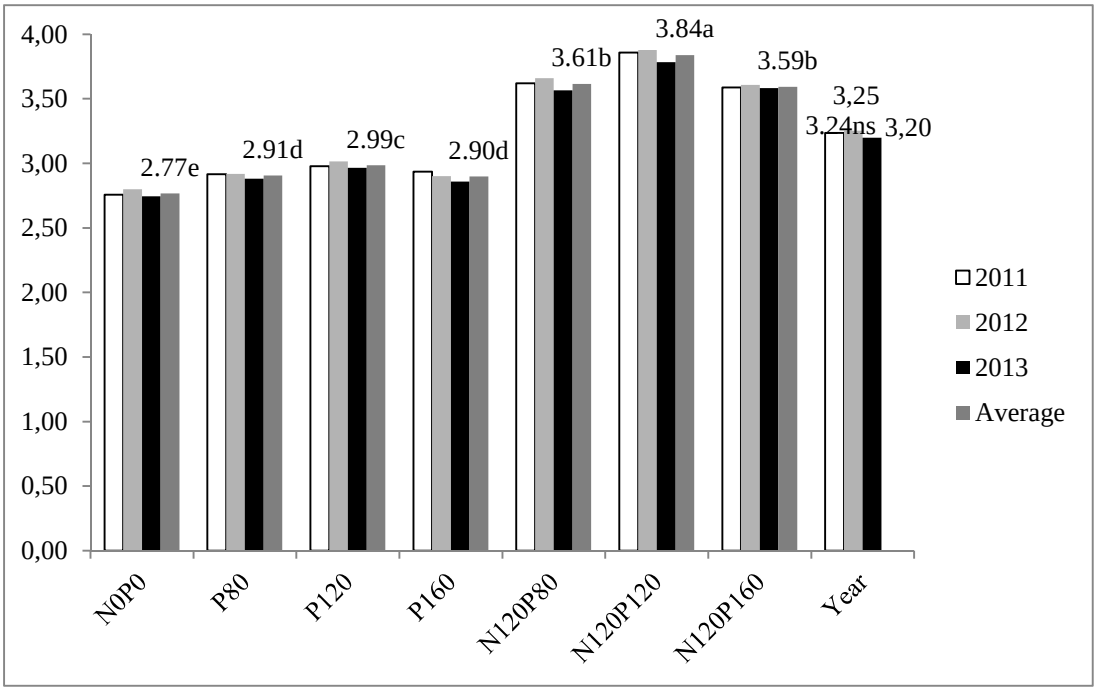

Figure 3. Expense of nitrogen (kg N for the formation of 100 kg grain) in cultivar Progress depends of the fertilization system

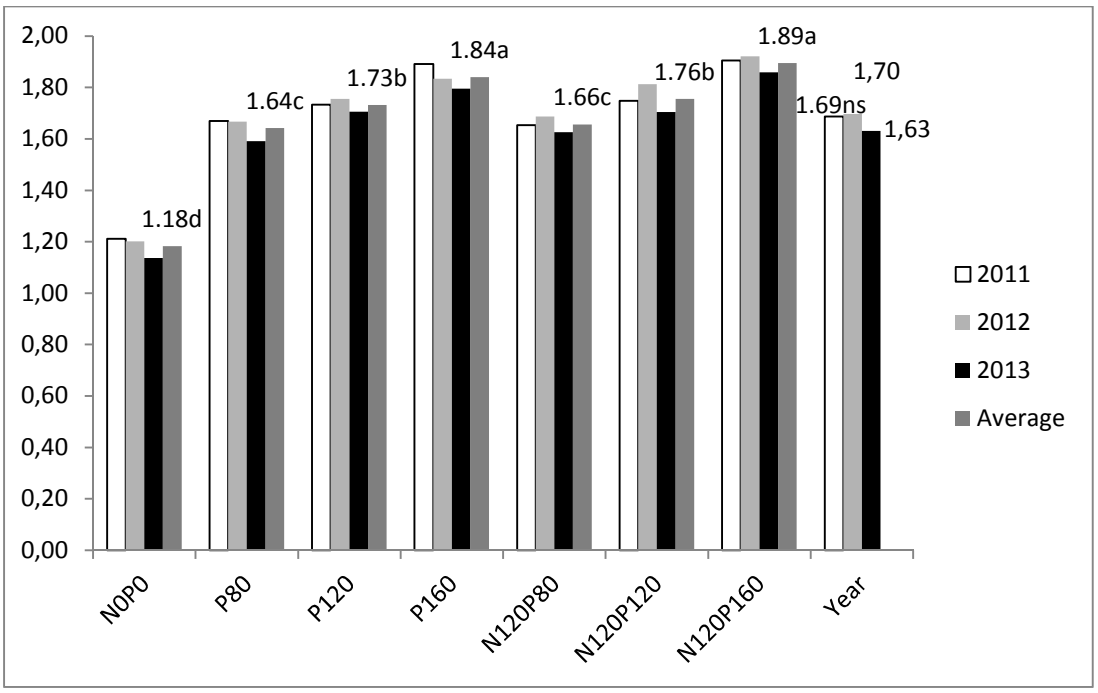

Figure 4. Expense of phosphorus (kg N for the formation of 100 kg grain) in cultivar Progress depends of the fertilization system

The expense of phosphorus in durum wheat cultivar Progress increased with increasing phosphorus fertilization rates for all fertilization systems as the highest expense was in combined nitrogen-phosphorus fertilization rate $N_{120}P_{160}$ - 1,89 kg, proven exceed the expense of control variant (without fertilization) by 60%. With the increasing phosphorus fertilization rates the expense of formation for 100 kg durum wheat grain increased, and when input the

nitrogen into the fertilization system and the differences was minimal and unproved, which indicated that the nitrogen was not affect the expense of phosphorus (Fig. 4).

Conclusion

It was established that productivity of aboveground biomass and grain was two-fold higher in fertilizing systems with applied N_{120} and phosphorus rates of 80 - 120 kg $P_2O_5.ha^{-1}$, compared to the systems with no phosphorus fertilizing.

Uptake efficiency of nitrogen and phosphorus or total uptake of these nutrients in aboveground dry mass at maturity, similar to wheat productivity, was higher in systems fertilized with nitrogen.

The uptake of nitrogen was in the range 52.5 – 166 kg $N.ha^{-1}$, and phosphorus uptake – 22.5 - 77.4 kg $P_2O_5.ha^{-1}$, in average for the period.

The highest expense of nitrogen for 100 kg grain formation was established in fertilizing system $N_{120}P_{120}$ – 3.84 kg N.

The expense of phosphorus for 100 kg grain formation increased in parallel with applied phosphorus rate and did not depend of nitrogen fertilizing.

The highest value was observed in systems with applied high phosphorus rate of $P_{160.}$ Nitrogen utilization efficiency for biomass and grain production in durum wheat was the lowest in fertilizing system $N_{120}P_{120}$, and the lowest phosphorus utilization efficiency was obtained in fertilizing treatment $N_{120}P_{160}$.

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