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Effect of nitrogen nutrition on nitrate dynamics of green pea

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ABSTRACT We studied the accumulation and dynamics of nitrate in green pea using rising rates of N-fertilisers and different nitrogen forms: nitrate, ammonium and together ammonium plus nitrate. The pot experiments were set up in greenhouse three planting dates with "Rajnai törpe" green pea variety. Samples were collected from the leafy stem at the growth stages of 4-6 leaves, in blossoming, and at maturity. Seed and pod samples were also analysed. We established that nitrate content of young pea plants was higher than that of the older ones at the optimal nitrogen nutrition levels. Nitrate-N stored increased throughout the growing season when N-supply was more than the optimum. The rising N-rates increased the nitrate content of leafy stems. Nitrate concentration of seed was little, but in pod was high over optimal N-supply. Nitrogen forms influenced the nitrate accumulation of leafy stem, seed and pod in different ways.
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KEY WORDS

green pea
nitrate dynamics
N-fertilization
N-forms

Green pea is an important vegetable, it is consumed freshly gathered or processed, often as a baby food. Its straw is a good fodder. Green pea is known as a plant, which accumulates only a little quantity of nitrate, because of it has a big nitrate reductase activity in the roots. In consequence of this the biggest part of uptaken nitrate reduces there and incorporates into the organic matter (Glaab-Kaiser 1993). According to Terbe et al. (1986) nitrate concentration of green pea is lower than 200 mg kg^{-1} fresh mass. But occasionally measured higher nitrate content into pea plants. Nitrogen nutrition plays an important role in nitrate accumulation of plants where the quantity and form of nitrogen are determinants (Barker-Maynard 1971; Lehmann 1977). The suggested nitrate limit of vegetables has already worked out in some countries but not in Hungary. The suggested nitrate limit of green pea seeds in Czechoslovakia was 220 mg kg^{-1} fresh mass (Prugar et al. 1991). The allowed nitrate limit in fodder is 3000 mg kg^{-1} fresh mass.

The aim of our experiments was to investigate the accumulation and dynamics of nitrate in green pea using rising rates of N-fertilisers and different nitrogen forms.

Materials and Methods

The pot experiments were set up in greenhouse three planting dates with "Rajnai törpe"green pea variety in four replications. Pots' contained 13 kg air-dried eroded clay lessivated brown forest soil (from Zalaapáti). We studied the effect of two nitrogen forms: nitrate as calcium-nitrate, ammonium as ammonium-sulphate, and ammonium-nitrate in mixture. Beside the control five N-treatments of 40, 80, 160, 320, and 640 mg kg^{-1} soil doses applied in solutions (abbreviated as 40N, 80N etc.) 120 mg kg^{-1} P_2O_5 and 200 mg kg^{-1} K_2O were employed before sowing. Water was dosed by weight using irrigation until the level of 60% of maximal water holding capacity. We wanted to study the dynamics of nitrate accumulation of pea because leafy stem samples were collected three times, at the growth stages of 4-6 leaves, in blossoming, and at maturity. Seed and pod samples were also analysed.

Nitrate content of dried and ground plant samples was determined photometricaly from the 1:8 rate water extract using hydrazine sulphate as reducing agent and N-(1-naphthyl)- ethylene-diamine plus sulphanilamide as colour producing reagents (Thammné 1990). From the Kjeldahl method plant digestion the total N was determined by dead-stop indication (Füleki 1970).

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Results and Discussion

In our experiments the rising N-rates increased gradually the nitrate content of leafy stems in all three phenological phases.

At the growth stages of 4-6 leaves we couldn't find measurable quantity of nitrate without N-fertilization (Fig. 1). With rising N-rates nitrate concentration continuously increased, in treatment, 640N was 1474 mg kg^{-1} fresh mass in the average of three applied N-fertilisers. At blossoming in 80N and 160N treatments -which were proved to be optimal doses for biomass production - decreased the nitrate concentration compared to the young plants (Fig. 2). The fresh mass strongly increased in these treatments so plants incorporated a lot of nitrogen to the biomass. On the other

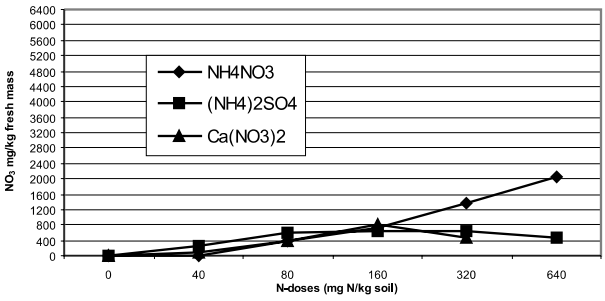

Figure 1. Effect of N-fertilizers on nitrate content of leafy stem at the growth stage of 4-6 leaves.

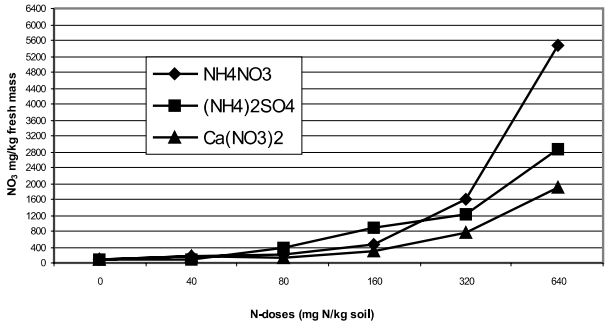

Figure 2. Effect of N-fertilizers on nitrate content of leafy stem at blossoming.

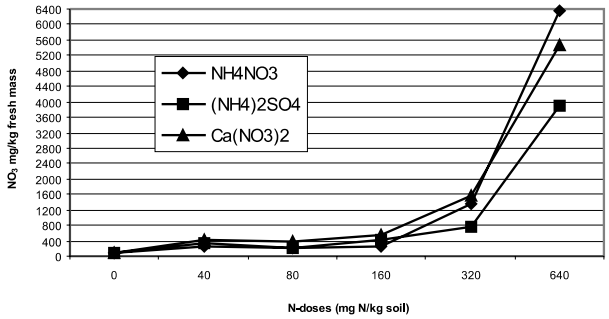

Figure 3. Effect of N-fertilizers on nitrate content of leafy stem at maturity.

hand in the control and treatments 40N and 640N where plants produced lower quantity of fresh mass and also 320N treatment the nitrate content was risen. It was the highest using 640 mg N kg^{-1} soil (3406 mg kg^{-1}).

At maturity comparing with blossoming the nitrate content increased again in 40N, 320N and 640N treatments (Fig. 3). In the plants of 640N was measured very high nitrate concentration, 5262 mg kg^{-1} fresh mass in the average of three applied N-fertilisers. In 80N treatment didn't changed, dosing 160 mg N kg^{-1} soil decreased the quantity of nitrate.

We established that nitrate content of young pea plants was higher than that of the older ones at the optimal nitrogen nutrition levels. Nitrate-N stored increased throughout the growing season when N-supply was higher than the optimum. It can explain by the extra N-supply. In consequence of this the nitrogen surplus couldn't incorporates to the organic compounds, so plants constrained to store as nitrate.

The nitrate content of the fresh mass of leafy stems in the 640N treatment was more than twice higher (6400 mg kg^{-1}) than the 3000 mg kg^{-1} fresh mass limit allowed in fodder. So, supervision of the nitrate accumulation of pea straw used as animal fodder is necessary.

Pea seed contained measurable quantity of nitrate only in the 320N and 640N treatments. Seed nitrate content was little so (the maximum of 237,7 mg kg^{-1} in ammonium-sulphate treatment) causing no problem in sensible infants. In the pod samples we also could find nitrate in the 320N and 640N treatments. But nitrate content in pods was too high (6669 mg kg^{-1} as maximum in ammonium-nitrate treatment) at the 640N treatment. From the point of view of nitrate accumulation the highest possible N-dose was 320 mg N kg^{-1} soil in our experiments.

We compared the effect of nitrogen forms on nitrate accumulation. The nitrogen form influenced significantly the nitrate contant of leafy stem only at the begining of growing.

Until blossoming the mixed ammonium plus nitrate nutrition later the nitrate form increased strongly the quantity of accumulated nitrate. Nitrogen forms had, no significant effect on nitrate accumulated by seeds. In the pods ammonium-nitrate induced the highest nitrate content.

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