Contents of chlorophyll and selected mineral components and the yield of common thyme (*Thymus vulgaris* L.) at differentiated nitrogen fertilization

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Summary

The vegetation experiment was carried out in pots, in an unheated greenhouse of Experimental Station 'Marcelin', Poznań University of Life Sciences. The studies were carried out on the effect of nitrogen nutrition on the herb fresh matter and on its dry crumbled matter as well as on the contents of chlorophyll *a* and *b*, nitrogen, magnesium and iron in leaves of common thyme of 'Słoneczko' cultivar. Nitrogen was applied in the form of NH_4NO_3 before vegetation (control – without nitrogen addition, 60, 120, 180 and 240 mg N dm^{-3} substrate) and as a top dressing with an addition of 60 mg N dm^{-3} in all variants with nitrogen fertilization. Herb harvest was carried out twice. It was found that nitrogen, irrespective of its dose, significantly decreased the level of chlorophyll *a* and *b* (on the average by 60%) and the iron content (on the average by 40%). The decreased chlorophyll level in thyme leaves with nitrogen application was positively correlated with iron content. No dependence was found between the level of chlorophyll and the nitrogen content in the herb. Nitrogen fertilization significantly increased both the yield of herb fresh matter and of the dry raw material. In case of dry raw material, no differences were found in the yield depending on the differentiated nitrogen nutrition.

Key words: *Thymus vulgaris, nitrogen nutrition, leaf mass, chlorophyll, N, Mg, Fe*

INTRODUCTION

From the ancient times, common thyme was a known therapeutic plant and seasoning herb [1]. Nowadays, it is one of the species with basic importance in European phytotherapy [2]. Thyme herb exerts apophlegmatic, disinfecting and antispastic actions. It is used in diseases of respiratory tract and in throat inflammation conditions as well as in diseases of the alimentary tract. Thyme raw material also represents a valuable addition to fodders [3].

Photosynthetic production determines in a high degree the biological yield of plants, i.e. the potential possibility of the production of fresh and dry matter per soil area unit, as well as the yield of useable organs. When the useable yield consists of leaves or of the whole aboveground parts, then the dependence between yield and the intensity of photosynthesis is very close [4].

Intensity of photosynthesis depends directly or indirectly on the provision of chlorophyll components, i.e. of nitrogen and magnesium as well as iron which is an activator of chlorophyll synthesis [5]. Chlorophylls are the most spread plant pigments. They are characterized by a high sensitivity to environmental factors evoking transformations in the structure of magnesium-porphyrin and the colour structure connected with them [6].

MATERIAL AND METHODS

In the years 2008–2009, thyme 'Słoneczko' cultivar plants were grown in an unheated greenhouse on the area of Experimental Station 'Marcelin' belonging to Poznań University of Life Sciences. Thyme was grown in pots of 6 dm^3 capacity filled with a substrate composed of mineral soil and raised peat mixed in a ratio of 1:1 (v:v). In order to obtain pH_{H20}=6.5, the substrate was limed on the basis of neutralization curve using 5 g of $CaCO_3$ dm^{-3} substrate. Nitrogen fertilizer (NH_4NO_3 form) was applied twice: pre-vegetatively (in 60, 120, 180 and 240 mg N dm^{-3} substrate) and as top dressing after the first harvest (in 60 mg N dm^{-3} substrate). Substrate without nitrogen fertilization was used as control. The other macro- and microelements constituted the background of the experiments. The following fertilizers were applied per dm^{-3} substrate: 80 mg P as $Ca(H_2PO_4)_2 \cdot H_2O$; 160 mg K as K_2SO_4; 80 mg Mg as $MgSO_4 \cdot 7H_2O$ and 80 mg Polichelat LS-7 (chelate polymer) in the following composition: 2.9% Mg, 2.9% Fe, l.9% Zn, 1.4% Mn, 1.3% Cu, 0.7% B and 0.1% Mo.

In the middle of May, the seedlings of thyme were planted into pots. The experiment was conducted in four replications. One replication included one pot with 3 clusters of 6–8 plants.

Plants were harvested twice: the first harvest was made before full flowering and the second one at the end of August. Leaves were separated from the stems, then dried in a ventilation drier at 30°C, subsequently ground and afterwards, the mass of air-dry leaves was determined.

Plant material was subjected to wet mineralization:

- in a mixture of sulphosalicylic acid, sodium thiosulphate and selenium mixture, followed by total nitrogen determination applying the distillation method with the use of Parnas-Wagner apparatus [7];
- in concentrated sulphuric acid Mg, by the method of atomic absorption (ASA), mixture of HNO_3 and $HClO_4$ acids in a ratio of 3:1, by ASA method.

The contents of chlorophylls *a* and *b* in the extract were determined spectrophotometrically [8].

The results of experiments are presented as mean values from two years. The two-way analysis of variance with Duncan's multiple range test was performed to determine the significance of differences at $p \leq 0.05$ for the mass of thyme leaves and the contents of chlorophyll *a* and *b* separately.

RESULTS AND DISCUSSION

It was found that the nutrition with nitrogen, independent from the applied dose, significantly decreased (on the average by 60%) the total content of chlorophyll in thyme leaves (fig. 1). This result is in contradiction with those of our own earlier studies in reference to sweet basil [9-11] and with the results of other authors [12] who reported that the increase of nitrogen dose caused at the same time an increase of chlorophyll content in leaves.

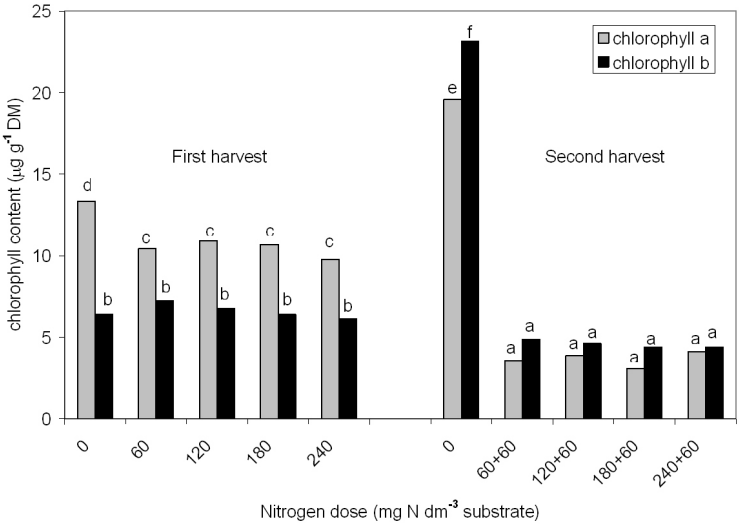

Figure 1. Effect of nitrogen fertilization on content of chlorophyll a and b in the leaves of thyme. Bars marked with the same letter do not differ significantly

It is commonly accepted that chlorophyll *a* is the main photoreceptor and its content in plants is 2–4 times higher than that of chlorophyll *b* [6].

In the presented studies, in the first harvest, the content of chlorophyll *a* dominated over chlorophyll *b* being by 1.6 times higher. On the other hand, in the second term of harvest, the situation was inverted: the content of chlorophyll *b* exceeded by 1.1 times the level of chlorophyll *a* in the control, while in variants with a differentiated nitrogen level in the substrate the differences were insignificant.

Particularly worth noticing is the control combination of the second harvest of leaves where it was found that not only the content of chlorophyll *a* was 1.5 times higher than chlorophyll *b*, but also the chlorophyll *b* content was 3.6 times higher in comparison to the control from the first harvest. Moreover, the control plants from second harvest, in comparison with plants nourished with nitrogen, were characterized, on the average, by 2.3 times higher content of chlorophyll *a* and by 2.1 times higher content of chlorophyll *b*.

Total nitrogen content in thyme leaves was insignificantly increased with the increase of N in the substrate (fig. 2). The highest total nitrogen content characterized the plant material from the first term of harvest, while in the second term of harvest, dependent of the applied dose of this component, its content was from 2.0 to 2.6 times smaller than the content in the first term. The same dependence was also found by us in our earlier studies on sweet basil [9-11].

Figure 2. Effect of nitrogen fertilization on the N-total content in the leaves of thyme

The level of magnesium in leaves, under the increasing doses of nitrogen, both in the first and in the second term of harvest, ranged similarly in the interval from 0.64% Mg (in the control without nitrogen, in the first harvest), to 0.85% Mg [at the dose of 240 mg N dm^{-3}, in the second harvest (fig. 3)]. However, the introduction of nitrogen into the substrate decreased significantly, on the average by 40%, the iron content in leaves (fig. 4). Furthermore, leaves from the second harvest accumulated less Mg than in the first term of harvest.

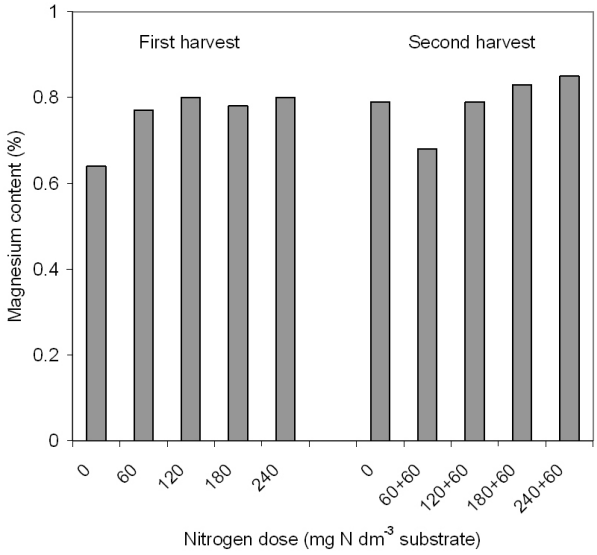

Figure 3. Effect of nitrogen fertilization on the magnesium content in the leaves of thyme

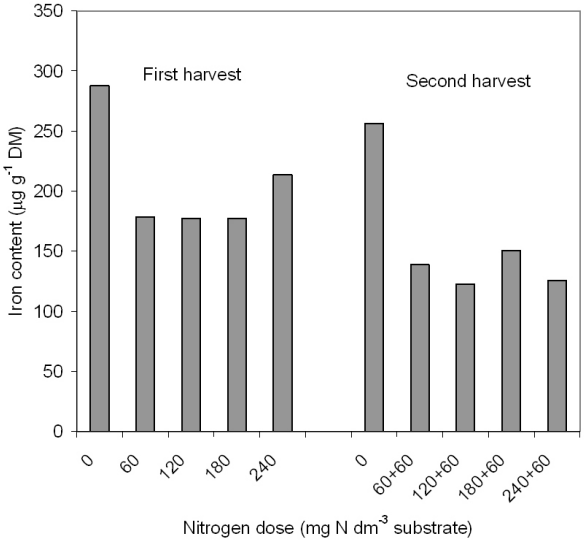

Figure 4. Effect of nitrogen fertilization on the iron content in the leaves of thyme

In control combination (without nitrogen application), the total yields of fresh and dry matter of thyme herb were significantly smaller than the yield from the combination where nitrogen was added to the substrate (fig. 5). Increasing doses of nitrogen did not differentiate significantly the yield of the fresh matter, and of the crumbled dried matter of the raw material, in both terms of harvest.

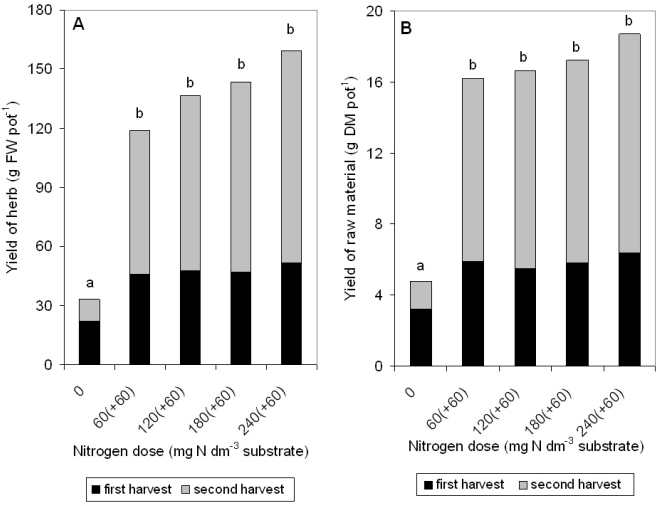

Figure 5. Effect of nitrogen fertilization of thyme on the fresh matter of herb (A) and the dry matter of raw material (B). Bars marked the same letter do not differ significantly

CONCLUSIONS

1. In thyme herb, no dependences were found between the nitrogen content in plants and the level of chlorophyll *a* and *b*.
2. Introduction of nitrogen to the substrate significantly decreased, regardless from the applied dose, the level of chlorophyll *a* and *b*, as well as the content of iron.
3. Decreased chlorophyll level in the leaves of thyme, where nitrogen was applied, was positively correlated with iron content.
4. Nitrogen nutrition highly significantly increased both the yield of fresh matter and of the dry matter of thyme herb.

REFERENCES

1. Lanska D. Jadalne rośliny dziko rosnące. Warszawa 1992.
2. Lutomski J. Znaczenie ziół w terapii i dietetyce. Wiad Ziel 2001; 6:7-9.
3. Seidler-Łożykowska K. Odmiany roślin zielarskich. Poznań 2008:23.
4. Politycka B, Kozłowska M. Fotosynteza i aktywność fotosyntetyczna roślin. W: Kozłowska M. (red.). Fizjologia roślin. Poznań 2007; 6:213-50.
5. Politycka B. Produktywność roślin. W: Kozłowska M. (red.). Fizjologia roślin. Poznań 2007; 10:353-72.
6. Dżugan M. Czynniki wpływające na stabilność zielonych barwników roślin. Południowo-Wschodni Oddział Polskiego Towarzystwa Inżynierii Ekologicznej z siedzibą w Rzeszowie. Polskie Towarzystwo Gleboznawcze, Oddział w Rzeszowie. Zeszyty Naukowe 2006; 7:26-33.
7. Nowosielski O. Zasady opracowywania zaleceń nawozowych w ogrodnictwie. Poznań 1988:193-241.
8. Hiscox JD, Israelstam GF. A method for the extraction of chlorophyll from leaf tissue without maceration. Can J Bot l979; 57:1332-4.
9. Markiewicz B, Golcz A, Kozik E. Effect of nitrogen fertilization and of harvest term on the field, content

of essentials oil and nitrogen in the herb of two cultivars of sweet basil *(Ocimum basilicum* L.). Rocz. AR Pozn. CCCXLI, Ogrod 2002; 35:19-24.
10. Golcz A, Markiewicz B. Effect of increasing nitrogen doses and harvest terms on the quantitative and qualitative parameters of sweet basil *(Ocimum basilicum* L.). Part II. Herba Pol 2002; 3:107-11.
11. Golcz A, Politycka B, Seidler-Łożykowska K. The effect of nitrogen fertilization and stage of plant development on the mass and quality of sweet basil leaves *(Ocimum basilicum* L.). Herba Pol 2006; 52:23-31.
12. Golińska B. Chlorofil jako wskaźnik azotowej kondycji wiechliny łąkowej w warunkach wielokrotnej defoliacji jej runi. Fragmenta Floristica Geobotanica Polonica 2007 (Supl. 9):137-45.

ZAWARTOŚĆ CHLOROFILU I WYBRANYCH SKŁADNIKÓW MINERALNYCH A PLON ZIELA TYMIANKU WŁAŚCIWEGO *(THYMUS YULGARIS* L.) PRZY ZRÓŻNICOWANYM ŻYWIENIU AZOTEM

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S t r e s z c z e n i e

Doświadczenie wegetacyjne przeprowadzono w pojemnikach w nieogrzewanej szklarni Stacji doświadczalnej „Marcelin" Uniwersytetu Przyrodniczego w Poznaniu. Badano wpływ zróżnicowanego żywienia azotem na masę ziela świeżego i otartego suchego, zawartość chlorofilu *a* i *b*, azotu, magnezu i żelaza w liściach tymianku właściwego 'Słoneczko'. Azot zastosowano jako NH_4NO_3 - przedwegetacyjnie (kontrola – bez dodatku azotu, 60, 120, 180, 240 mg N dm^{-3} podłoża) i pogłównie dodając 60 mg N dm^{-3} podłoża we wszystkich wariantach z nawożeniem azotowym. Zbioru ziela dokonano dwukrotnie. Stwierdzono, że azot, niezależnie od dawki, istotnie obniżał poziom chlorofilu *a* i *b* (średnio o 60%) oraz zawartość żelaza (średnio o 40%). Obniżony poziom chlorofilu w liściach tymianku z zastosowanym azotem był skorelowany dodatnio z zawartością żelaza. Nie stwierdzono zależności pomiędzy poziomem chlorofilu *a* i *b* a zawartością azotu w zielu. Żywienie azotem wysoce istotnie zwiększyło zarówno plon masy surowca świeżego, jak i otartego. W przypadku ziela otartego nie stwierdzono różnic w plonie w zależności od zróżnicowanego nawożenia azotem.

Słowa kluczowe: *Thymus vulgaris, żywienie azotem, masa liści, chlorofil, N, Mg, Fe*