



CHANGES IN THE CONTENT OF TOTAL NITROGEN AND MINERAL NITROGEN IN THE BASIL HERB DEPENDING ON THE CULTIVAR AND NITROGEN NUTRITION

KATARZYNA DZIDA *, ZBIGNIEW JAROSZ, KAROLINA PITURA

Abstract. Among fundamental nutrients, nitrogen fertilization is considered one of the most effective factors affecting both the yield and the quality of plant material. Nitrogen form used for fertilizing is also of great importance. The aim of this study was to investigate the impact of nitrogen nutrition (calcium nitrate, ammonium nitrate, and urea) as well as (green, purple, and 'Fino Verde') on the chemical composition and yielding of basil (*Ocimum basilicum* L.). After drying the plant material at a temperature of 60°C and milling, total nitrogen was determined by means of Kjeldahl method, while mineral nitrogen content (N-NH₄, N-NO₃) was analyzed in 2% acetic acid extract. Yield of fresh basil matter depended significantly on the variety grown. The highest yields were obtained from a cultivar of 'Fino Verde' fertilized with ammonium nitrate. The purple variety plants fertilized with urea were characterized by a largest amount of total nitrogen. The 'Fino Verde' cultivar fertilized with urea accumulated the least quantities of nitrates in the basil herb.

Key words: *Ocimum basilicum*, herb, nitrogen, basil, cultivar, fertilization

Department of Cultivation and Fertilization of Horticultural Plants, University of Sciences in Lublin, 58 Leszczyńskiego, 20-068 Lublin, Poland; *katarzyna.dzida@up.lublin.pl

Introduction

Interests in common basil essentially results from three reasons. First of all, the plant is an excellent spice, and it is often even the essence of food. Secondly, basil is a medicinal plant widely used against various diseases and ailments. It is also a valuable oil-producing plant, which is applied in aromatherapy and cosmetics (GOLCZ & SEIDLER-ŁOŻYKOWSKA 2008; OMER *et al.* 2008; NURZYŃSKA-WIERDAK 2012). Firms purchasing herbs attach more and more attention to the fact that the plant material was of the best quality.

Plant yielding, not just the basil, is a function of many variables. These include factors such as soil fertility shaped by the chemical and air-water properties of soil, weather conditions such as temperature and precipitation, as well as fertilization (ABASSI *et al.* 2005). The latter of these factors can largely shape the quantity of obtained yields and their quality. Among the primary nutrients, nitrogen fertilization is considered one of the most effective factors affecting both the yield and quality

of plant material (MARKIEWICZ *et al.* 2002; ABASSI *et al.* 2005; SIFOLA & BARBIERI 2006). The form of nitrogen used for fertilizing is also of a great importance (BIESIADA *et al.* 2010). Plants absorb nitrogen throughout the growing season, thus the supply of this nutrient is very important and difficult at the same time. Therefore, it is important to know the rules of plant nutrition using this macronutrient (NURZYŃSKI 2008). Factors dependent on the plant itself, e.g. species or variety, play an important role in the variability of the chemical composition of plant material as well as the crop size (BIESIADA *et al.* 2010). There are around 200 different basil species, which have developed many varieties and forms in the wild, which differ in morphology, growth, and chemical composition (NURZYŃSKA-WIERDAK 2001, 2007a, 2007b; ŠVECOVÁ & NEUGEBAUEROVÁ 2010).

The paper aims at investigating the impact of nitrogen fertilization (calcium nitrate, ammonium nitrate, and urea) and cultivar (green, purple, and 'Fino Verde') on the chemical composition and yielding of basil (*Ocimum basilicum* L.).

Table 1. Effect of cultivar and nitrogen fertilizer on plant height and plant unit weight in basil herb.

Cultivar	Nitrogen fertilizer	Plant height (cm)	Plant unit weight (g · plant ⁻¹)
Green	Ca(NO ₃) ₂	62,9	200,5
	NH ₄ NO ₃	60,8	195,5
	CO(NH ₂) ₂	70,1	211,7
Mean for green		64,6	202,6
Violet	Ca(NO ₃) ₂	47,1	109,3
	NH ₄ NO ₃	44,1	105,0
	CO(NH ₂) ₂	48,5	110,3
Mean for violet		46,6	108,2
'Fino verde'	Ca(NO ₃) ₂	60,4	273,0
	NH ₄ NO ₃	61,1	286,3
	CO(NH ₂) ₂	61,5	255,8
Mean for 'Fino verde'		61,0	271,7
Mean for	Ca(NO ₃) ₂	56,8	194,3
	NH ₄ NO ₃	55,3	195,6
	CO(NH ₂) ₂	60,0	192,6
LSD α=0,05			
cultivar		2,274	22,492
nitrogen fertilizer		2,274	n.s.
cultivar × nitrogen fertilizer		5,271	n.s.

Material and methods

The study involving common basil (*Ocimum basilicum*) of green, purple, and 'Fino Verde' varieties were conducted in spring 2011 at the Department of Cultivation and Nutrition of Horticultural Plants, located in the experimental farm of the University of Life Sciences in Felin.

Basil plants were sown on 24th March, planted out on 7th April, while planted into their constant site on 22nd April. The experiment included a total of 90 plants and it was set up by means of complete randomization design in nine series in ten replicates, in which a single pot of 2 dm³ capacity with a single plant, was the replicate. The substrate was composed of peat with pH 4.5 acidity, which was limed using calcium carbonate up to pH 6.0. Following mineral fertilization was applied in the experiment (g · dm⁻³): 0.6 N as: calcium nitrate (15.5% N), ammonium nitrate (34% N), and urea (46% N), 0.5 P as granular triple superphosphate (20% P),

1.0 K as potassium sulfate (42% K), and 0.4 Mg in the form of magnesium sulfate (15.6% Mg). A full dose of phosphorus and microelements as well as ¼ dose of nitrogen, potassium, and magnesium was used prior to basil planting. Other rates of nutrients (N, K, Mg) were applied as post-crop in three doses in following terms: 4th May, 19th May, and 1st June. Plants were watered depending on a temperature inside the greenhouse.

At the time of experiment liquidation, the plant height was measured and aboveground parts of basil were weighed thus determining the yield of fresh matter. After drying the plant material at 60°C temperature and grinding, total nitrogen content was determined by means of Kjeldahl method in Kjeltec 2002 Distilling System Unit. The content of mineral nitrogen in forms of N-NH₄ and N-NO₃ in plant material was determined in 2% acetic acid extract by distillation due to Bremner method with modification by Starck (NOWOSIELSKI 1988).

Achieved results of fresh matter yields and plant height were statistically processed applying variance analysis and mean values, as well as indicating the significance of differences by means of Tukey test at a significance level of $\alpha = 0.05$.

Results and discussion

The experiment with common basil yielded some interesting results upon the effects of different forms of nitrogen on the development of selected cultivars of basil.

Studies indicated that the yield of crops depended on the cultivar grown. The highest weight of fresh matter was produced by '*Fino Verde*' cultivar, whereas the lowest – purple cultivar (Tab. 1).

ŠVECOVÁ & NEUGEBAUEROVÁ (2010) in their experiment also demonstrated a significant effect of a cultivar on the yield size. The experiment included 34 cultivars. Among all studied cultivars, '*Fino Verde*' produced the highest fresh matter weight. The impact of a basil cultivar on its yield was also confirmed by experiments of GOLCZ *et al.* (2006), NURZYŃSKI-WIERDAK (2007b), and NURZYŃSKA-WIERDAK *et al.* (2011a). Although the statistical analysis showed no significant effect of nitrogen forms on the basil yield, there was a difference in the yield between the cultivar grown and a form of nitrogen used. In objects, where green cultivar plants fertilized with urea were grown, a yield of $211.7 \text{ g} \cdot \text{plant}^{-1}$ was obtained. In the case of ammonium nitrate fertilization, the yield was lower and amounted to $195.5 \text{ g} \cdot \text{plant}^{-1}$. A converse situation was recorded in the study upon the '*Fino Verde*' cultivar. Plants fertilized with urea produced the lowest yield ($255.8 \text{ g} \cdot \text{plant}^{-1}$) and those treated with ammonium nitrate - the highest yield ($286.3 \text{ g} \cdot \text{plant}^{-1}$). OMER *et al.* (2008) performed an experiment, in which American basil (*Ocimum americanum* L.) was grown in two vegetation cycles and fertilized in three different nitrogen fertilizers: ammonium sulfate, ammonium nitrate, and urea. In both seasons, the total yield of herb, after using ammonium sulfate, exceeded the yield obtained after ammonium nitrate

and urea application. The effect of ammonium nitrate and urea on fresh matter yield was not univocal, as higher yield was achieved using ammonium nitrate in the first growing season, while the use of urea in the second period influenced on the higher yield of herb. The experiment carried out by DZIDA (2011) on the effect of calcium nitrate, ammonium nitrate, and urea on common basil did not show any effect of nitrogen forms applied on the yield of fresh herb. Only cultivar remarkably differentiated the yield of fresh matter.

The determinations show that both the cultivar, the nitrogen form, and the correlation between these factors had a significant impact on the basil plant height. The studies revealed that green cultivar was the highest of three tested basil cultivars, while purple one was the shortest. Similar results were obtained by DZIDA (2011), when examining the impact of the type of nitrogen fertilizer on plant height of different basil cultivars. The influence of basil cultivar on its height was also demonstrated in experiments of other authors (NURZYŃSKA-WIERDAK 2007b; ŠVECOVÁ & NEUGEBAUEROVÁ 2010). In own study, the green cultivar fertilized with urea was the tallest. Plants treated with ammonium nitrate were the shortest of all green basil nutrition combinations. In the case of a purple cultivar, the effect of fertilizers on the plant height was the same. The least noticeable effect of the nitrogen form on the basil height was recorded for '*Fino Verde*'. DZIDA (2011) achieved different results, because plants fertilized with calcium nitrate were the tallest, while those treated with urea reached the smallest height. In another experiment, ADLER *et al.* (1989) showed that basil fertilized with ammonium form of nitrogen was shorter than that treated with nitrates.

Results from the analyses clearly show the relationship between the cultivar and forms of nitrogen vs. nitrate accumulation in plant material (Fig. 1). Most of N-NO_3 is contained at plants fertilized with calcium nitrate, especially the purple cultivar (1.04% DM). The lowest proportions of nitrates were accumulated by basil plants treated with urea, especially '*Fino Verde*' (0.02% DM) and green basil cultivar. Total

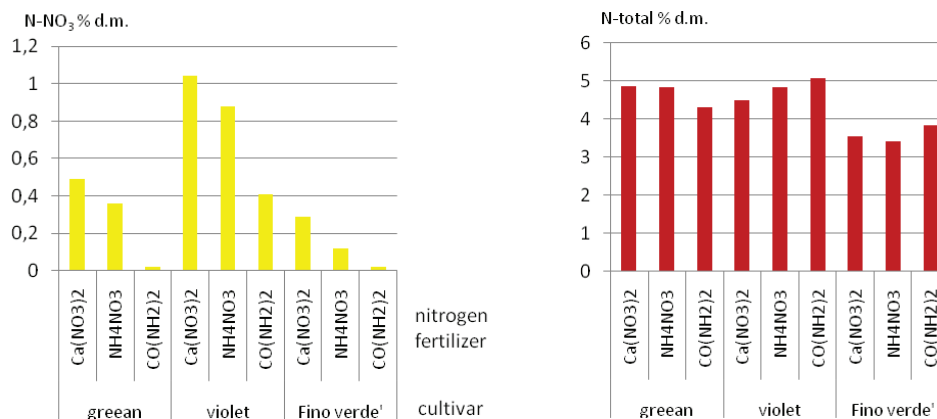


Fig. 1. Effect of cultivar and nitrogen fertilizer on content N-NO₃ and N-total in basil herb.

nitrogen content was mainly dependent on the cultivar. As in the case of nitrates accumulation, the largest quantities of nitrogen were found in purple cultivar, whereas the lowest in 'Fino verde'. A significant impact of a cultivar on the total nitrogen content was recorded in the study by DZIDA (2010). Experiment conducted by NURZYŃSKA-WIERDAK *et al.* (2011a, 2011b) revealed the relationship between the cultivar grown vs. nitrates and total nitrogen content in the plant. The 'Opal' cultivar was characterized by the largest amount of total nitrogen and N-NO₃ in plant material. Analysis of the research by GOLCZ *et al.* (2006), involving also 'Opal' cultivar, indicates the highest total nitrogen content of all tested basil cultivars. It was demonstrated in numerous studies that the use of fertilizers containing N-NO₃ resulted in an increase in the nitrate concentration at basil and other herb plants. HALVA & PUUKLA (1987) found the highest concentration of nitrates in basil herb after the application of calcium nitrate.

Similar relationship was reported by TESI *et al.* (1995). Applying ammonium sulfate resulted in the nitrate content in the herb half of that when calcium nitrate was used. DZIDA (2011) found that tested nitrogen fertilizers differentiated the concentration of nitrate at basil plants. The highest nitrate content was determined in the herb plants fertilized with ammonium nitrate, lower due to calcium nitrate,

and the lowest nitrate content was recorded in basil herbs treated with urea.

Conclusions

1. Basil fresh weight yield depended significantly on the cultivar grown. The highest yields were obtained from 'Fino Verde' cultivar fertilized with ammonium nitrate.
2. The purple basil cultivar treated with urea was characterized by the largest amount of total nitrogen.
3. 'Fino Verde' cultivar fertilized with urea accumulated the lowest quantities of nitrates in the basil herb.

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