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# YIELD AND QUALITY OF LEAFY PARSLEY AS AFFECTED BY THE NITROGEN FERTILIZATION

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**Abstract.** Leafy parsley is a spice rich in vitamins and minerals widely used in West European countries in fresh, dried and frozen form to enhance the flavor of many foods. In Poland till now the leaves of tuber-rooted parsley are commonly produced for this purpose. Little information is available with respect to the effects of N fertilization on yield and crop quality of different type of leafy parsley cultivars. In a field experiment conducted in 2005–2007 nitrogen fertilizer in the same amount of 160 kg N· $ha^{-1}$ was supplied as a single preplant or split dose (80 + 80 kg N·$ha^{-1}$, and 80 + 40 + 40 kg N·$ha^{-1}$). In the other treatment the split dose was reduced to 120 kg N·$ha^{-1}$, (40 + 40 + 40 kg N·$ha^{-1}$). There was determined the yield, dry matter, vitamin C, total N and nitrates content in leaves of two cultivars (Paramount and Titan) in three subsequent harvests. Irrespective of N fertilization, Paramount-a curled leaf cultivar producent higher yield of leaves with favourable percentage of blades and was a richer source of vitamin C, with higher tendency than Titan for nitrates accumulation. Single preplant nitrogen application was preferable for leaf growth and yield only in the first term of harvest which contained lower amounts of vitamin C, and showed higher tendency for total N and nitrates accumulation compared with split doses. The most favourable method of leafy parsley nutrition was the application of 80 kg N·$ha^{-1}$ before seedlings transplanting, and the same amount in two top dressing doses used directly after subsequent harvests. Gradual decrease of dry matter, vitamin C, and nitrates while the increment of total N contents was observed at the subsequent harvests of leaves during the growing period.

**Key words:** methods of N application, Paramount cv., Titan cv., crop yield, leaves composition

## INTRODUCTION

Leafy parsley (*Petroselinum sativum* L. var. *crispum*) is still a minor crop in Poland, like in the other Central and East European countries where Hamburg type of this species is widely cultivated on commercial scale, both for harvest the fleshy roots and

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abundant leaf rosettes [Rumpel and Kaniszewski 1994, Kmiecik and Lisiewska 1999]. Leaves of both types of this species are appreciated for their valuable biological properties. They are a rich source of vitamins C and E, β-caroten, minerals (especially potasium, calcium, phosphorus and iron) crude fibre and protein [Bąkowski and Michalik 1986, Buchter-Weisbrodt 2005].

Comparison studies conducted by Kmiecik [1995], Lisiewska and Kmiecik [1997], Kmiecik and Lisiewska [1999] proved that leafy type of parsley produced higher yield characterised by beneficial share of leaf blades in total above ground biomass, containing lower amounts of dry matter and vitamin C, showing higher tendency for nitrates accumulation than tuber rooted one.

Leafy parley is recognized as a spice native to the countries of the Mediterranean region. It is widely used in fresh, dry or frozen from to enhance the flavour of many different foods. Essential oil obtained mostly from the seeds may be used in the food industry or as a fragrance of perfume manufacturing [Diaz-Maroto et al. 2002]. The principal constituent of essental oil is apiol, followed by β-phellandrene and myristicin.

Upon the base of morphological features of leaf blades the leafy parsley may be divided in to two groups [Simon and Quinn 1988]: curled (var. *crispum*) and plane leaf (var. *neapolitanum*) cultivars. Curled-leaf cultivars are often prefered by the consumers but the investigations of Araj and Witek [1994] indicated a plane – leaf as the superior with respect to many quality features, including aromatic properties.

Little information may be found in the literature with respect to relations between nitrogen fertilization, yield and biological value of parsley leaves. Rumpel and Kaniszewski [1994] stated that turnip-rooted parsley grown in the field fertilized with farmyard manure at the rate of 40 $t\cdot ha^{-1}$ did not show any response to the supplemental mineral N application. Negligible effects of this nutrient was also observed in the trial conducted by Pasikowska et al. [2002] with two leafy parsley cultivars supplied within the range of 50 to 120 kg $N\cdot ha^{-1}$. Sady [2006] recommends to use the soil test in order to enhance the mineral soil nitrogen level ($NO_3$+$NH_4$) to 60–80 $mg\cdot dm^3$ of the soil. According to the recommendation elaborated by Krug [1991] the most favourable effects in cultivation of this crop may be obtained in the case if 100 kg $N\cdot ha^{-1}$ will be applied as preplant dose and 25–30 kg $N\cdot ha^{-1}$ as a top dressing directly after each subsequent harvest of leaves.

The aim of present study was to evaluate the yield and quality of two types of leafy parsley under influence of time of application and rate of nitrogen.

## MATERIAL AND METHODS

Field experiment was conducted in 2005–2007 in Piastów Horticultural Experimental Station on a heavy clay soil, with pH 6.8–7.0 and organic matter content 1.8%. Two cultivars of parsley: Paramount-a curled leaf type and Titan a plane-leaf one were grown at differentiated time and rate of nitrogen fertilization. A single preplant dose equal to160 $kg\cdot ha^{-1}$ was compared with split application of this nutrient. In treatment with 80 + 80 kg $N\cdot ha^{-1}$ half of the dose was supplied before seedlings planting and the other one directly after first cutting the leaves. In two other treatments (80 + 40 + 40 kg

N·ha$^{-1}$ and 40 + 40 + 40 kg N·ha$^{-1}$) the top dressing doses were applied after subsequent harvest of leaves. The experiment was established in two factorial design in four replications and plot area amounted 2.16 m$^2$ (1.8 × 1.2 m).

The content of available forms of phosphorus and potassium were supplemented by early spring fertilization to the level of 60 mg P and 200 mg K per 1 dm$^3$ of the soil. Ammonium nitrate, triple superphosphate and potassium chloride were used as the sources of nutrients.

Seeds of both tested cultivars were sown on 20 February in the greenhouse into the multiseeded trays with cell volume 69.3 cm$^3$, filled with peat substrate. One week before planting well developed trasplants were hardened in not heated plastic tunnel and then planted in the field in half of April in spacing 30 × 15 cm, which assured the population of 22 plants per 1 m$^2$. Crop management included hand weeding of plots and irrigation of plants in the rainfall deficiency periods.

Harvest of leaves was conducted three times, within 1–5 of July, 25–30 August and 10–15 October depending on the year of the study. All leaves were cut 5 cm over the ground and separated into different fractions. There were evaluated the total yield of cut biomass, marketable yield which contained leaves with petioles long enough to tide in bunches suitable for the demand of fresh market, as well as leaf petioles usable for the industrial purpose. In samples of the whole leaves collected during each harvest separately from 3 replications there were determined the content of dry matter (by drying at 105°C to the constant weight), vitamin C (Tillman's method), total N (Kjeldahl's method) and nitrates expressed by the amounts of $NO_3$ in f.w. (ion selective electrode, Orion's method).

The results of the experiment were subjected to analysis of variance for the experiment established in split-block design. The least significant differences between means were calculated by Tukey test at $\alpha = 0.05$.

## RESULTS AND DISCUSSION

**Crop yield.** Results of the study shown as the means for there years of field experiment indicate a significant impact of both tested factors on total and marketable yield of leafy parsley (tab. 1).

Among the compared cultivars Paramount produced higher yields of total above ground biomass as well as marketable yield of leaves than Titan. The only exception were the yields obtained during the third cutting in which the differences between cultivars were not significant.

These results are in agreement with the data obtained in the other experiment, in which Titan – a plane leaf cultivar produced lower marketable yield of leaves than Paramount, especially in the second and third term of harvest [Dyduch and Janowska 2004]. Another favourable feature of Paramout cv. was the higher share of the blades which are considered as the most suitable part of plants for processing [Kmiecik and Lisiewska 1999]. Irrespective of the term of applications and dose of N, the yield of leaf blades obtained from Paramount cv. amounted 2.77 kg·m$^{-2}$, while for Titan 2.25 kg·m$^{-2}$, and their percentage in marketable yield was equal to 65.2% and 55.8%, respectively (tab. 2).

Table 1. The effect of nitrogen fertilization on total and marketable yield of leafy parsley (mean for 2005–2007 in kg· $m^{-2}$)

Tabela 1. Wpływ nawożenia azotem na plon całkowity i handlowy pietruszki naciowej (średnio za lata 2005–2007 w kg· $m^{-2}$)

| | Term of application and rate of N (kg·$ha^{-1}$) Termin nawożenia i dawka N | Ist term of harvest I termin zbioru | | | IInd term o harvest II termin zbioru | | | IIIrd term of harvest III termin zbioru | | | Total yield from 3 harvests Plon łączny z 3 zbiorów | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Paramount | Titan | $\bar{x}$ | Paramount | Titan | $\bar{x}$ | Paramount | Titan | $\bar{x}$ | Paramount | Titan | $\bar{x}$ |
| Yield of total above ground biomass Plon całkowity masy nadziemnej roślin | 160 | 2.05 | 1.88 | 1.97 | 1.62 | 1.64 | 1.63 | 1.85 | 1.95 | 1.90 | 5.53 | 5.47 | 5.50 |
| | 80 + 80 | 1.97 | 1.68 | 1.83 | 1.86 | 1.68 | 1.77 | 1.84 | 2.25 | 2.05 | 5.67 | 5.61 | 5.64 |
| | 80 + 40 + 40 | ↓ | ↓ | ↓ | 1.69 | 1.64 | 1.67 | 2.35 | 2.64 | 2.50 | 6.01 | 5.96 | 5.99 |
| | 40 + 40 + 40 | 1.86 | 1.56 | 1.71 | 1.78 | 1.45 | 1.62 | 2.45 | 2.24 | 2.35 | 6.09 | 5.25 | 5.67 |
| | mean – średnia | 1.96 | 1.71 | 1.84 | 1.74 | 1.61 | 1.67 | 2.13 | 2.27 | 2.20 | 5.83 | 5.57 | 5.70 |
| | LSD α = 0.05 for – dla: | | | | | | | | | | | | |
| | N fertilization – nawożenia N | | | 0.11 | | | n.s – n.i. | | | 0.10 | | | 0.14 |
| | cultivar – odmiany | | | 0.16 | | | 0.12 | | | n.s – n.i. | | | 0.21 |
| Marketable yield of leaves Plon handlowy liści | 160 | 1.65 | 1.58 | 1.62 | 1.15 | 1.10 | 1.13 | 1.18 | 1.18 | 1.18 | 3.98 | 3.87 | 3.93 |
| | 80 + 80 | 1.53 | 1.35 | 1.44 | 1.41 | 1.24 | 1.33 | 1.23 | 1.42 | 1.33 | 4.17 | 4.01 | 4.09 |
| | 80 + 40 + 40 | ↓ | ↓ | ↓ | 1.17 | 1.12 | 1.15 | 1.69 | 1.92 | 1.81 | 4.39 | 4.39 | 4.39 |
| | 40 + 40 + 40 | 1.46 | 1.25 | 1.36 | 1.20 | 0.97 | 1.09 | 1.78 | 1.63 | 1.71 | 4.47 | 3.85 | 4.16 |
| | mean – średnia | 1.55 | 1.39 | 1.47 | 1.23 | 1.11 | 1.17 | 1.47 | 1.54 | 1.51 | 4.25 | 4.03 | 4.14 |
| | LSD α = 0.05 for – dla: | | | | | | | | | | | | |
| | N fertilization – nawożenia N | | | 0.10 | | | 0.14 | | | 0.09 | | | 0.12 |
| | cultivar – odmiany | | | 0.13 | | | 0.10 | | | n.s – n.i. | | | 0.19 |

Table 2. The effect of nitrogen fertilization on yield of leaf blades and their percentage participation in marketable yield (mean for 2005–2007)

Tabela 2. Wpływ nawożenia azotem na plon blaszek liściowych i ich procentowy udział w plonie handlowym (średnio za lata 2005–2007)

| | Term of application and rate of N (kg·ha$^{-1}$) Termin nawożenia i dawka N | Ist term of harvest I termin zbioru | | | IInd term of harvest II termin zbioru | | | IIIrd term of harvest III termin zbioru | | | Total yield from 3 harvests Plon łączny z 3 zbiorów | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Paramount | Titan | $\bar{x}$ | Paramount | Titan | $\bar{x}$ | Paramount | Titan | $\bar{x}$ | Paramount | Titan | $\bar{x}$ |
| Yield of leaf blades (kg· m$^{-2}$) Plon blaszek liściowych (kg· m$^{-2}$) | 160 | 1.10 | 1.89 | 1.00 | 0.84 | 0.68 | 0.76 | 0.67 | 0.61 | 0.64 | 2.61 | 2.18 | 2.40 |
| | 80 + 80 | 1.04 | 1.81 | 0.93 | 0.98 | 0.72 | 0.85 | 0.72 | 0.70 | 0.71 | 2.74 | 2.23 | 2.49 |
| | 80 + 40 + 40 | ↓ | ↓ | ↓ | 0.81 | 0.73 | 0.77 | 0.99 | 0.90 | 0.95 | 2.84 | 2.44 | 2.64 |
| | 40 + 40 + 40 | 0.96 | 0.72 | 0.84 | 0.85 | 0.63 | 0.74 | 1.07 | 0.78 | 0.93 | 2.88 | 2.13 | 2.51 |
| | mean – średnia | 1.03 | 0.81 | 0.92 | 0.87 | 0.69 | 0.78 | 0.86 | 0.75 | 0.81 | 2.77 | 2.25 | 2.51 |
| | LSD α = 0.05 for – dla: | | | | | | | | | | | | |
| | N fertilization – nawożenia N | | | 0.08 | | | 0.07 | | | 0.06 | | | 0.08 |
| | cultivar – odmiany | | | 0.11 | | | 0.10 | | | 0.08 | | | 0.14 |
| | term of application and rate of N (kg·ha$^{-1}$) termin nawożenia i dawka N | Ist term of harvest I termin zbioru | | | IInd term of harvest II termin zbioru | | | IIIrd term of harvest III termin zbioru | | | Mean percentage for 3 harvest Średni udział procentowy z 3 zbiorów | | |
| | | Paramount | Titan | $\bar{x}$ | Paramount | Titan | $\bar{x}$ | Paramount | Titan | $\bar{x}$ | Paramount | Titan | $\bar{x}$ |
| Percentage share of leaf blades in marketable yield Procentowy udział blaszek liściowych w plonie handlowym | 160 | 66.7 | 56.3 | 63.3 | 73.0 | 61.8 | 67.3 | 56.8 | 51.7 | 54.2 | 65.6 | 56.3 | 61.1 |
| | 80 + 80 | 68.0 | 60.0 | 64.6 | 69.5 | 58.1 | 63.9 | 58.5 | 49.3 | 53.4 | 65.7 | 55.6 | 60.9 |
| | 80 + 40 + 40 | ↓ | ↓ | ↓ | 70.8 | 64.9 | 67.9 | 60.1 | 47.9 | 54.4 | 64.4 | 55.3 | 60.3 |
| | 40 + 40 +4 0 | 65.8 | 57.6 | 61.8 | 69.2 | 65.2 | 66.9 | 58.6 | 46.9 | 52.5 | 64.7 | 55.6 | 60.1 |
| | mean – średnia | 66.5 | 58.3 | 62.6 | 70.7 | 62.2 | 66.7 | 58.5 | 48.7 | 53.6 | 65.2 | 55.8 | 60.6 |

Table 3. The effect of nitrogen fertilization and term of harvest on dry matter and vitamin C contents in leafy parsley (mean for 2005–2007)

Tabela 3. Wpływ nawożenia azotem i terminu zbioru na zawartość suchej masy i witaminy Cw liściach pietruszki naciowej (średnio za lata 2005–2007)

| | Term of application and rate of N (kg·ha$^{-1}$) Termin nawożenia i dawka N | Ist term of harvest I termin zbioru | | | IInd term o harvest II termin zbioru | | | IIIrd term of harvest III termin zbioru | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Paramount | Titan | $\bar{x}$ | Paramount | Titan | $\bar{x}$ | Paramount | Titan | $\bar{x}$ |
| Dry matter (%) Sucha masa (%) | 160 | 20.28 | 18.86 | 19.57 | 18.69 | 16.74 | 17.72 | 16.60 | 16.36 | 16.48 |
| | 80 + 80 | 20.61 | 19.55 | 20.08 | 17.57 | 18.67 | 18.12 | 16.53 | 16.47 | 16.50 |
| | 80 + 40 + 40 | ↓ | ↓ | ↓ | 17.08 | 16.26 | 16.67 | 16.07 | 16.25 | 16.16 |
| | 40 + 40 + 40 | 20.57 | 19.79 | 20.18 | 18.08 | 18.05 | 18.07 | 15.94 | 16.02 | 16.28 |
| | Mean – Średnia | 20.49 | 19.40 | 19.95 | 17.86 | 17.43 | 17.65 | 16.29 | 16.25 | 16.36 |
| | LSD α = 0.05 for – dla: | | | | | | | | | |
| | N fertilization – nawożenia N | | | n.s – n.i. | | | n.s – n.i. | | | n.s – n.i. |
| | cultivar – odmiany | | | 0.06 | | | n.s – n.i. | | | n.s – n.i. |
| Vitamin C (mg %) Vitamin C (mg %) | 160 | 275.4 | 277.6 | 276.5 | 258.5 | 245.1 | 251.8 | 231.0 | 200.7 | 215.9 |
| | 80 + 80 | 312.6 | 280.5 | 296.6 | 256.5 | 254.8 | 255.7 | 213.3 | 202.3 | 207.8 |
| | 80 + 40 + 40 | ↓ | ↓ | ↓ | 245.3 | 242.7 | 244.0 | 223.1 | 190.8 | 207.0 |
| | 40 + 40 + 40 | 311.2 | 298.8 | 305.0 | 253.2 | 264.7 | 259.0 | 220.7 | 191.8 | 206.3 |
| | Mean – Średnia | 299.7 | 285.6 | 292.7 | 253.4 | 251.8 | 252.6 | 222.0 | 196.4 | 209.2 |
| | LSD α = 0.05 for – dla: | | | | | | | | | |
| | N fertilization – nawożenia N | | | 17.1 | | | n.s – n.i. | | | n.s – n.i. |
| | cultivar – odmiany | | | 10.07 | | | n.s – n.i. | | | 13.2 |

Table 4. The effect of nitrogen fertilization and term of harvest on total N and nitrates content in leafy parsley (mean for 2005–2007)

Tabela 4. Wpływ nawożenia azotem i terminu zbioru na zawartość N ogólnego i azotanów w liściach pietruszki naciowej (średnio za lata 2005–2007)

| | Term of application and rate of N<br>Termin nawożenia i dawka N<br>($kg \cdot ha^{-1}$) | Ist term of harvest<br>I termin zbioru | | | IInd term o harvest<br>II termin zbioru | | | IIIrd term of harvest<br>III termin zbioru | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Paramount | Titan | $\bar{x}$ | Paramount | Titan | $\bar{x}$ | Paramount | Titan | $\bar{x}$ |
| Total N<br>(% d.m.)<br>Azot ogółem<br>(% s.m) | 160 | 2.34 | 2.54 | 2.44 | 2.71 | 2.80 | 2.76 | 2.81 | 2.93 | 2.87 |
| | 80 + 80 | 2.22 | 2.37 | 2.30 | 3.21 | 2.59 | 2.90 | 2.77 | 3.11 | 2.94 |
| | 80 + 40 + 40 | ↓ | ↓ | ↓ | 2.97 | 3.03 | 3.00 | 3.16 | 3.29 | 3.23 |
| | 40 + 40 + 40 | 2.11 | 2.35 | 2.23 | 2.84 | 2.64 | 2.74 | 3.08 | 3.30 | 3.19 |
| | mean – średnia | 2.22 | 2.41 | 2.32 | 2.93 | 2.77 | 2.85 | 2.96 | 3.16 | 3.06 |
| | LSD α = 0.05 for – dla: | | | | | | | | | |
| | N fertilization – nawożenia N | | | 0.07 | | | 0.16 | | | 0.11 |
| | cultivar – odmiany | | | 0.12 | | | n.s – n.i. | | | n.s – n.i. |
| Nitrates<br>($mg \cdot kg^{-1}$ f.w.)<br>Azotany<br>($mg \cdot kg^{-1}$ św.m.) | 160 | 583 | 433 | 508 | 418 | 287 | 353 | 221 | 187 | 204 |
| | 80 + 80 | 382 | 205 | 294 | 317 | 233 | 275 | 202 | 201 | 202 |
| | 80 + 40 + 40 | ↓ | ↓ | ↓ | 280 | 185 | 233 | 169 | 188 | 179 |
| | 40 + 40 + 40 | 363 | 185 | 294 | 275 | 168 | 222 | 181 | 185 | 183 |
| | mean – średnia | 443 | 274 | 359 | 323 | 218 | 271 | 193 | 190 | 192 |
| | LSD α = 0.05 for – dla: | | | | | | | | | |
| | N fertilization – nawożenia N | | | 37 | | | 29 | | | 16 |
| | cultivar – odmiany | | | 49 | | | 41 | | | n.s – n.i. |

Single preplant nitrogen fertilization at the rate of 160 kg·ha$^{-1}$ was beneficial for plant growth and crop yield only in the first term of harvest conducted in early July. This effect may be explained by the lower doses supplied in the plots with split application of this nutrient, which were 40 and 80 kg N·ha$^{-1}$. Some advantageous effect of split N application was observed during the second and much more pronounced during the last term of cutting. Taking into account the sum of the yields obtained during the whole growing season, the most favourable method of N application was the use of 80 kg N·ha$^{-1}$ as a preplant dose, and the same amount in two equal top dressings directly after the first and second cutting the leaves. Good effects were also assured in treatment with reduced N level to120 kg N·ha$^{-1}$, divided into 40 kg N·ha$^{-1}$ doses applied as a preplant fertilization and two similar top dressings. Total and marketable yield of leaves from these plots were similar to the use of 160 kg N·ha$^{-1}$ in split application (80 + 80 kg N·ha$^{-1}$), and significantly higher if compared to the same level of nitrogen supplied in a single preplant fertilization. Similar relations were observed between the yield of leaf blades and the method and level of N application. Percentage share of leaf blades in marketable yield did not show any response to nitrogen fertilization.

**Plant composition.** Chemical analysis of the samples of leaf blades and petioles of parsley collected at each time of harvest showed the influence of cultvars as well as term of harvest on determined quality features (tab. 3–4). Like in the yield, no interaction was found between two tested factors and crop composition.

Dry matter content in the leaves of Paramount cv. was generally higher than in Titan cv., but only in the first term of cutting the results were significantly different.

Like in the experiments conducted by the other authors [Bąkowski and Michalik 1986, Wills et al. 1986, Grzeszczuk et al. 2005] parsley leaves appeared to be a very rich source of vitamin C, with reasonable level of nitrates accumulation. Vitamin C content in Paramount cv. maintained at the level of 222.0–299.7 mg%, while in Titan cv. within 196.4–285.6 mg% depending on the term of harvest. The nitrate content varied within 193–443 mg·kg$^{-1}$ and 190–274 mg·kg$^{-1}$ of fresh weight in compared cultivars, respectively. Higher tendency for nitrate accumulation by the curled – leaf cultivars was also previously observed in parsley [Pasikowska et al. 2002] and spinach cultivation [Barker and Maynard 1971, Barker et al. 1971]. In the present study the high content of vitamin C and nitrates in Paramount cv. was found to be significant in two out of three terms of harvest. The uptake of total N was not closely related to nitrates accumulation and only in the first cutting the leaves of Titan cv. contained significantly higher amount of this nutrient.

Dry matter content was not affected by the method and rate of nitrogen fertilization, while the level of vitamin C in the first term of cutting was negatively influenced by the increasing preplant fertilization from 40 to 160 kg N·ha$^{-1}$. Irrespective to the time of harvest, there was observed a considerable effect of nitrogen fertilization on total N and nitrates content in leaves. At the first harvest term in early July there was obtained the enhancement of total N from 2.23% d.m. to 2.44% d.m. and nitrates from 294 to 508 mg·kg$^{-1}$ f.w. in treaments with 40 kg N·ha$^{-1}$ and 160 kg N·ha$^{-1}$, respectively. During two other cuttings of leaves, split application of N at the same rate as in the single preplant dose resulted in higher uptake of total nitrogen but significantly lower accumulation of nitrates. These results did not confirm the statement of Pasikowska et al. [2002]

who did not notice any uniform effects of N fertilization on nitrate accumulation in growing parsley on three different soil types.

It could be recognized as an interesting finding that content of dry matter, vitamin C, and nitrates showed a pronounced and gradual decrease along with growing season. The only exception was total N, which was taken up in the highest amounts by plants harvested in October. The decrement of nitrates accumulation in October at poorer light condition than during summer months may be surprised, and explained by low temperature of the air and soil at this period of time. Results obtained by Cantliffe [1972] with spinach indicate that at reasonable N fertilization, low temperature is a restricted factor for nitrates uptake by plants. Also Frota and Tucker [1972] proved that higher soil temperature is more favourable for the uptake of $NO^{-}_{3}$ than $NH_4^+$ ions.

## CONCLUSION

1. Paramount-a curled leaf cultivar produced higher yields of leaves with more favourable percentage of blades in marketable crop and content of vitamin C than Titan--plant leaf cultivar. The beneficial feature of Titan cv was smaller tendency for nitrate accumulation.

2. The best method of parsley fertilization with nitrogen was the application of 80 kg $N \cdot ha^{-1}$ as the preplant dose, and the same amount in two equal top dressing doses used directly after subsequent leaf harvests.

3. Gradual decrease of dry matter, vitamin C and nitrates while enhancement of total N in leaves was observed along with the growing period of parsley.

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## PLONOWANIE I JAKOŚĆ PIETRUSZKI NACIOWEJ W ZALEŻNOŚCI OD ZRÓŻNICOWANEGO NAWOŻENIA AZOTEM

**Streszczenie.** Pietruszka naciowa jako warzywo przyprawowe bogate w witaminy, związki mineralne i olejki eteryczne posiada w krajach Europy Zachodniej szerokie zastosowanie w postaci świeżej, suszonej bądź mrożonej dla podniesienia wartości smakowej wielu potraw. W Polsce wykorzystuje się najczęściej w tym celu liście pietruszki korzeniowej. Brak jest dotychczas w literaturze światowej danych odnośnie wpływu nawożenia azotem na plon i jakość różnego typu odmian pietruszki naciowej. W doświadczeniu polowym przeprowadzonym w latach 2005–2007 azot w tej samej dawce wynoszącej 160 kg $N \cdot ha^{-1}$ stosowano w całości przedwegetacyjnie bądź w dawce podzielonej (80 + 80 kg $N \cdot ha^{-1}$ i 80 + 40 + 40 kg $N \cdot ha^{-1}$). W badaniach uwzględniono także obniżoną do 120 kg $N \cdot ha^{-1}$ dawkę tego składnika (40 + 40 + 40 kg $N \cdot ha^{-1}$). Przedmiotem oceny była wielkość plonu liści oraz zawartość suchej masy, witaminy C, azotu ogółem i azotanów w liściach dwóch odmian pietruszki (Paramount i Titan) w 3 kolejnych terminach zbioru. Niezależnie od metody nawożenia N odmiana Paramount posiadająca liście kędzierzawe wydała większy plon liści, z większym udziałem blaszek liściowych, zawartością witaminy C przy większej jednocześnie tendencji do gromadzenia azotanów niż odmiana Titan. Przedwegetacyjne zastosowanie całej dawki azotu wpłynęło korzystniej na plonowanie pietruszki jedynie w I terminie zbioru, przyczyniło się jednocześnie do mniejszej zawartości witaminy C i większej akumulacji azotanów oraz zawartości N ogólnego w stosunku do dawki podzielonej. Najlepsze wyniki w uprawie tej rośliny zapewniło nawożenie w dawce 80 kg $N \cdot ha^{-1}$ przed posadzeniem rozsady oraz takiej samej ilości tego składnika w dwóch dawkach pogłównych bezpośrednio po przeprowadzeniu kolejnych zbiorów. Zawartość suchej masy, witaminy C i azotanów w liściach ulegała obniżeniu, zaś N ogólnego zwiększeniu w miarę upływu okresu wegetacji.

**Słowa kluczowe**: metoda nawożenia N, Paramount, Titan, plon , skład chemiczny liści

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