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INFLUENCE OF DIVERSIFIED FERTILIZATION ON NITRATES CONTENTS IN SOIL AND IN WILD STRAWBERRY FRUITS

WPŁYW ZRÓŻNICOWANEGO NAWOŻENIA NA ZAWARTOŚĆ AZOTANÓW W GLEBIE I W OWOCACH POZIOMKI

Abstract: The objective of an experiment conducted in 2005–2007 was to determine the effect of the application of composted bark (20 Mg · ha^{-1} d.m.) and manure (20 Mg · ha^{-1} d.m.) on the nitrate content of soil and wild strawberry fruits. Both compost and manure caused an increase in the content of readily hydrolyzable nitrogen (by 66 % and 79 % respectively) and N-NO_3 (by 165 % and 188 % respectively) in soil, compared with the control treatment. Elevated levels of readily mineralizable nitrogen and N-NO_3 in soil contributed to an increase in the total nitrogen content of wild strawberry fruits, by 20.4 % and 29.7 % respectively. Organic fertilization had no significant effect on N-NO_3 accumulation in wild strawberry fruits.

Keywords: wild strawberry fruits, soil, nitrates, organic fertilization, bark compost, manure

The wild strawberry cultivation on a productive scale is not as widespread as the cultivation of other fruits [1]. Currently, there is a significant growth in the interest in this plant because of its dietetic values. The national and international literature includes only a few works on the cultivation of this type of plant. The accurate growth of this plant is determined by the composition of the nutritive components in the soil [2]. The aim of this work was to compare the effect of the organic fertilizers (manure and bark compost) on the content of nitrates in the soil and in the fruits of the wild strawberries.

Materials and methods

A field trial was carried out in 2005–2007. Wild strawberries cv. Baron Solemacher were grown in light soil containing 20 % silt and clay, as well as available nutrients in

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the following amounts: P – 18 mg · kg^{-1}, K – 80 mg · kg^{-1}, Mg – 17 mg · kg^{-1}, Ca – 106 mg · kg^{-1} soil, pH 5.8 in 1M KCl. Wild strawberries were planted in strips and rows, with two rows 50 cm apart within the strip and planting distance of 40 cm within the row. The entire wild strawberry plantation was mulched with straw during the growing season.

The experiment, performed in three replications, involved three treatments: 1 – control without fertilization, 2 – fertilization with composted bark in the amount of 20 Mg · ha^{-1} d.m., 3 – fertilization with manure in the amount of 20 Mg · ha^{-1} d.m. The fertilizers were ploughed in to a depth of 20 cm. The macronutrient content of fertilizers is given in Table 1.

Table 1

Macronutrient content of fertilizers

Fertilizer	N	P	K	Mg	Ca
	[g · kg^{-1} d.m.]				
Bark compost	12.0	13.2	37.1	1.8	4.7
Manure	25.3	14.0	47.0	2.9	4.3

Total nitrogen content was determined by the Kjeldahl method, N-NO_3 content was measured spectrophotometrically (PN-R04028), and readily hydrolyzable nitrogen content was estimated by the Cornfield method. Soil samples for chemical analyses were collected during flowering and fruiting, and at the end of the growing period. The levels of total nitrogen (Kjeldahl method) and N-NO_3 (colorimetric method with the use of phenyl disulfonic acid) were determined in wild strawberry fruits immediately after harvest.

Fruits were harvested from June 4 to October 15 each year, at 10–15 day intervals.

Results

Since the yield and quality of wild strawberry fruits depend not only on fertilization but also on weather conditions, average air temperatures and precipitation totals during the growing season (from March to October) are presented below:

Year	Temperature [^{o}C]	Rainfall [mm]
2005	10.25	360.16
2006	17.73	483.60
2007	12.56	563.36

The content of total nitrogen, readily hydrolyzable nitrogen and nitrate nitrogen in soil affects plant nutrition (Table 2). Total nitrogen levels did not change significantly throughout the experimental period or as a result of fertilization. Readily hydrolyzable nitrogen is unstable, it undergoes rapid mineralization and may be taken up by plants [3]. The content of this nitrogen fraction was significantly affected by fertilization – it increased 1.66-fold and 1.79-fold, compared with the control treatment, following the

application of compost and manure respectively. This is consistent with the findings of Mazur [4]. An analysis of quantitative changes in the above nitrogen fraction in particular years of the study showed that the year 2006 provided favorable conditions for its accumulation in the soil environment. Fertilization had a profound effect on the $N\text{-}NO_3$ content of soil, which increased 2.66-fold and 2.88-fold following the application of compost and manure, respectively. The increase in the levels of both nitrogen fractions was accompanied by an increase in their percentage share of total nitrogen. A similar dependency was noted by Mazur [5].

Table 2

The content of various nitrogen fractions in soil
(mean values of three sample collections)

Object	Years	Total N [mg · kg^{-1}]	Hydrolyzable nitrogen		$N\text{-}NO_3$	
			[mg · kg^{-1}]	content in total N [%]	[mg · kg^{-1}]	content in total N [%]
Control	2005	107.0	10.8	10.1	6.8	6.4
	2006	108.0	23.3	12.3	7.2	6.7
	2007	108.1	10.2	9.4	5.4	5.0
	mean	107.7	14.8	13.7	6.5	6.0
Bark compost	2005	108.0	24.2	22.4	16.9	15.6
	2006	109.5	26.4	24.1	18.4	16.8
	2007	107.9	23.8	22.0	16.6	15.4
	mean	108.5	24.8	22.8	17.2	15.9
Manure	2005	113.3	26.4	23.3	17.0	15.0
	2006	101.9	28.8	28.3	19.8	19.4
	2007	110.6	24.4	22.1	19.2	17.4
	mean	108.6	26.5	24.4	18.7	17.2
$LSD_{0.05}$		n.s.	9.05		2.31	

The content of total nitrogen and nitrate nitrogen in wild strawberry fruits is presented in Table 3. In the compost-fertilized treatment, total nitrogen content increased 1.20-fold. Manure was found to have a more beneficial effect on total nitrogen content which increased 1.3-fold in the treatment fertilized with manure, in comparison with the control treatment (Fig. 1), which agrees with the findings of Feadi and Baruzzi [2]. Fertilization caused no significant changes in $N\text{-}NO_3$ content, while the proportion of $N\text{-}NO_3$ in total nitrogen decreased along with an increase in total nitrogen concentrations. Similar results were reported by Caruso et al [6]. In fertilized treatments, total nitrogen content decreased in the third year, and in the treatment with manure application also in the second year of the study. The same trend was observed with respect to $N\text{-}NO_3$ content, including in the control treatment. According to Tagliavini et al [7] and Tworkowski et al [8], the nitrate content of fruits may vary depending on weather conditions, the age of plants and nitrogen accumulation in roots.

Table 3

The total nitrogen content and nitrate(V) in the fruits of the wild strawberries

Object	Years	Total N [mg · kg^{-1} f.m.]	N-NO_3 [mg · kg^{-1} f.m.]	N-NO_3 content in total N [%]
Control	2005	120.3	45.5	37.4
	2006	123.6	42.8	34.6
	2007	122.5	30.6	25.0
	mean	122.1	39.6	32.4
Bark compost	2005	155.5	40.5	26.0
	2006	142.8	45.2	31.6
	2007	142.6	37.4	26.2
	mean	147.0	41.0	27.9
Manure	2005	165.0	49.6	30.1
	2006	160.2	42.0	26.2
	2007	150.0	34.6	23.1
	mean	158.4	42.1	26.6
$LSD_{0.05}$		12.4	n.s.	

Figure 1 illustrates the effect of fertilization on both nitrogen fractions. Relative data support the findings of other authors [1, 9], pointing to a more beneficial impact of manure than compost.

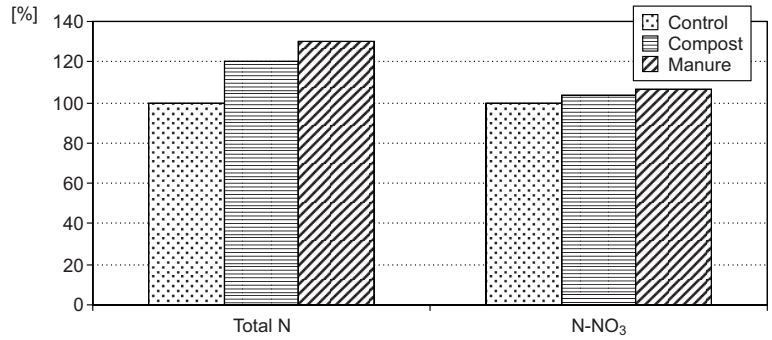

Fig. 1. The influence of fertilization on total nitrogen and nitrate(V) content in wild strawberry fruits (relative, mean values in three years)

Conclusions

1. The application of compost and manure to wild strawberries contributed to an increase in the content of readily hydrolyzable nitrogen (by 66 % and 79 %, respectively) and N-NO_3 (by 165 % and 188 %, respectively) in soil, compared with the control treatment.

2. The application of compost and manure caused an increase in the total nitrogen content of wild strawberry fruits, by 20.4 % and 29.7 %, respectively, in comparison with the control treatment.

3. Fertilization had no significant effect on $N\text{-}NO_3$ accumulation in wild strawberry fruits.

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WPŁYW ZRÓŻNICOWANEGO NAWOŻENIA NA ZAWARTOŚĆ AZOTANÓW W GLEBIE I W OWOCACH POZIOMKI

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Abstrakt: W latach 2005–2007 przeprowadzono doświadczenie, w którym badano wpływ nawożenia kompostem z kory w dawce 20 Mg · ha^{-1} s.m. i obornika 20 Mg · ha^{-1} s.m. na zawartość azotanów w glebie i owocach poziomki. Stosowanie kompostu i obornika spowodowało wzrost zawartości w glebie N-łatwo hydrolizującego o 66 % i 79 %, a $N\text{-}NO_3$ o 165 % i o 188 % w stosunku do kontroli. Wzrost zawartości w glebie azotu łatwo ulegającego mineralizacji i $N\text{-}NO_3$ wpłynęło na kumulację w owocach poziomki N-ogółem o 20,4 % i o 29,7 %. Zastosowane nawożenie organiczne nie miało statystycznie istotnego wpływu na kumulację $N\text{-}NO_3$ w owocach poziomki.

Słowa kluczowe: owoce poziomki, gleba, azotany, nawożenie organiczne, kompost z kory, obornik