THE IMPACT OF NITROGEN FERTILIZATION ON YIELD AND THE CONCENTRATION OF MACROELEMENTS IN ROOT CHICORY *CICHORIUM INTYBUS* L. VAR. *SATIVUM* BISCH.

Bożena Cwalina-Ambroziak[1], Jadwiga Wierzbowska[2], Bożena Bogucka[3]
[1] Department of Entomology, Phytopathology and Molecular Diagnostics, [2] Department of Agricultural and Environmental Chemistry,
[3] Department of Agrotechnology and Agribusiness, **University of Warmia and Mazury in Olsztyn, Poland**
e-mail: bambr@uwm.edu.pl

INTRODUCTION. High quality of vegetables, a group of plants produced intensively, particularly depends on appropriate selection of varieties and suitable mineral fertilization. Root chicory, a dietetic vegetable with nutritional and health-promoting qualities, is a rich source of carbohydrates, fibre vitamins (A, C and group B), lutein (carotenoids), anthocyanins (flavonoids) and minerals. The effect of N fertilization on yield and content of macronutrients in chicory roots was assessed.

MATERIAL AND METHODS. In a plot experiment, conducted at the Agricultural Experiment Station in Tomaszkowo near Olsztyn, (in 2016-2018), three root chicory cultivars were grown: Polanowicka (Poland), Orchies and Chrysolite (France). Seeds were sown in the last ten days of April, on plots 3.6 m^2 (3 x 1.2 m) in area each, in 3 rows, 15 cm apart in each row, and rows spaced at 40 cm. The experiment was laid out in a randomized subblock design (blocks – levels of fertilization; varieties – subblocks) with three replications. Three levels of topsoil N fertilization were applied (46% urea, single application) before sowing: 0, 80 and 120 kg ha^{-1}. Fertilization also included 73 kg P_2O_5 (46% granulated triple superphosphate) and 115 kg K_2O (60% potash salt) per ha^{-1}. Roots were harvested between 10 and 20 of October. 5 roots were picked at random from each plot. They were washed and cut into 1x1x1 cm cubes, after which they were freeze-dried and ground in a mill. The content of N, P, K, Ca, Mg and Na was determined in the material mineralized in concentrated H_2SO_4 with added H_2O_2 (N by the Kjeldahl method, P – by colorimetry with the vanadate-molybdate method, K, Ca and Na – by atomic emission spectrophotometry, and Mg – by atomic absorption spectrophotometry), while the S content was determined by nephelometry, following the mineralization of material in a mixture of $HClO_4$ and HNO_3.

Tab. 1. Meteorological data during the experiment in 2016-2018

Month	x temp °C				∑ opadów mm			
	2016	2017	2018	1981-2010	2016	2017	2018	1981-2010
April	7,4	5,7	10.8	**7,7**	28,8	59,1	33.5	**33,3**
May	13,7	12,1	15.7	**13,5**	56,9	25,1	25.0	**58,5**
June	17,1	15,7	17.2	**16,1**	69,3	74,5	53.7	**80,4**
July	18,1	16,8	19.7	**18,7**	130,4	107,6	141.0	**74,2**
August	17,1	17,4	19.2	**17,9**	70,4	63,1	44.6	**59,4**
September	13,6	12,8	14.5	**12,8**	21,1	168,1	20.3	**56,9**
October	6,1	8,7	8.7	**8,0**	104,3	114,9	84.7	**42,6**
x monthly/ ∑	**13.3**	**12.7**	**15.1**	**13.5**	**481.2**	**612.4**	**402.8**	**405.3**

RESULTS AND DISCUSSION. The analysed experimental factors, cultivar and dose of N fertilization, as well as the weather conditions had an effect on the yield of chicory roots and concentrations of macronutrients contained in roots. Higher root yield produced by the three chicory cultivars was obtained in warm and moderately humid growing season of 2018 (57.25 Mg ha^{-1} on average) than in the other years. The highest yield was harvested in 2017 from cv. Chrysolite not fertilized with nitrogen (83Mg ha^{-1}). The average mass of roots of this cultivar was 62.25 Mg ha^{-1}. Roots of the cv. Polanowicka were found to have the highest content of N and K (in the fertilization variant 120 kg N ha^{-1}), Ca and Mg (80 kg N ha^{-1}) and S (0 kg N ha^{-1}). The cultivar Chrysolite accumulated most P (80 kg N ha^{-1}), while cv. Orchies accumulated most Na (120 kg N ha^{-1}). Higher concentration of macronutrients was determined in roots harvested from the plots fertilized with 80 and 120 kg N ha^{-1} than ones with 0 kg N ha^{-1} (no fertilization). The above data confirm the average concentrations determined for the varieties and N fertilization doses.

The dry matter (DM) content of chicory roots was highest in cv. Orchies, that were harvested in 2018 (32%). In the current study, N nitrogen fertilization and cultivars did not induce differences in DM content of chicory roots.

Tab. 2. Yield of cichorium roots Mg ha^{-1} / t ha^{-1}

	Polanowicka			Chrysolite			Orchies		
	0 kg N	80 kg N	120kgN	0 kg N	80 kg N	120kgN	0 kg N	80 kg N	120kgN
2016	35.14g-j	29.56ij	22.14j	57.56b-f	53.03c-f	58.06b-f	50.97d-g	41.31f-i	44.11e-i
2017	41.39f-i	46.03e-i	47.86e-h	83.00a	60.50b-e	45.58e-i	56.58b-f	52.47c-g	22.86j
2018	49.89e-h	48.92e-h	33.03hij	67.44a-d	68.89abc	67.97a-d	73.14ab	67.08a-d	40.42f-i
x	**40.14C**	**41.50C**	**34.42C**	**69.22A**	**60.81B**	**56.58B**	**60.23B**	**53.62B**	**35.81C**

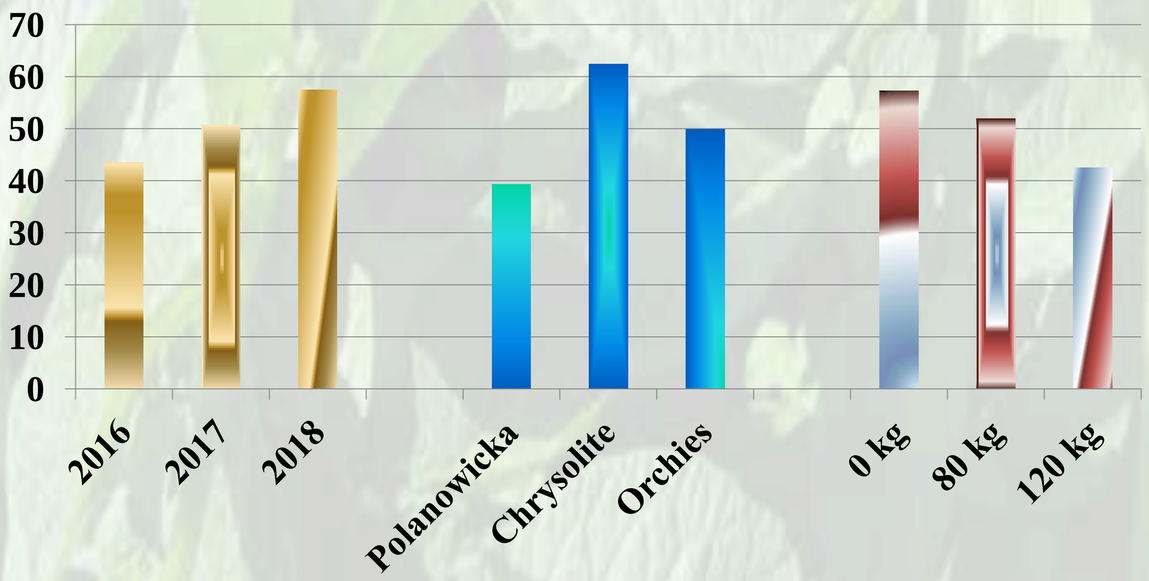

Fig. 2. Yield of cichorium roots Mg ha^{-1}

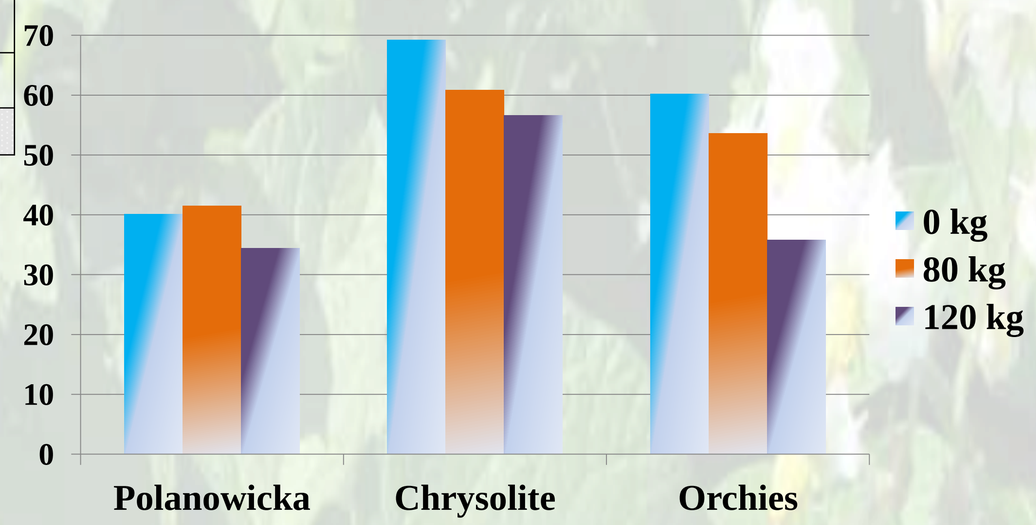

Fig. 1. Impact of cultivar and nitrogen dose on yield of cichorium roots Mg ha^{-1}

Tab. 3. Content of macroelements in cichorium roots g kg^{-1} s.m.

	N	P	K	Ca	Mg	Na	S
2016	8.66b	5.05a	23.37b	2.05a	0.86a	0.42b	0.85a
2017	10.19a	3.83b	24.26b	1.26b	0.83a	0.54a	0.87a
2018	8.51b	3.45c	26.54a	1.26b	0.87a	0.55a	0.86a
Polanowicka	**10.36a**	**4.18a**	**27.20a**	**1.65a**	**0.92a**	**0.47b**	**0.93a**
Chrysolite	**8.36b**	**4.08a**	**24.28b**	**1.58a**	**0.81b**	**0.51ab**	**0.84a**
Orchies	**8.64b**	**4.07a**	**22.69c**	**1.34b**	**0.84b**	**0.53a**	**0.81a**
0 kg N	**7.83b**	**4.15a**	**23.89a**	**1.43a**	**0.83a**	**0.51a**	**0.86a**
80 kg N	**9.39 a**	**4.21a**	**25.40a**	**1.66a**	**0.90a**	**0.49a**	**0.88a**
120 kg N	**10.15a**	**3.97a**	**24.89a**	**1.49a**	**0.84a**	**0.52a**	**0.84a**

Tab. 4. Zawartość suchej masy w korzeniach cykorii g kg^{-1} s.m.

	Polanowicka	Chrysolite	Orchies	x
0 kg N	30.46a	27.95a	30.39a	**29.60 A**
80 kg N	28.38a	28.06a	29.03a	**28.49 A**
120 kg N	28.17a	29.26a	30.55a	**29.33 A**
2016	29.60ab	28.65abc	28.51abc	**28.92 A**
2017	31.58a	26.87bc	29.50ab	**29.32 A**
2018	25.83c	29.75ab	31.96a	**29.18 A**
x	**29.00 A**	**28.43 A**	**29.99 A**	