Ministerstwo Rolnictwa i Rozwoju Wsi

InHort INSTYTUT OGRODNICTWA

Reducing nutrient losses and soil contamination through rational fertilization of ornamental plants

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INTRODUCTION

In horticulture, especially in soilless cultivation and intensively fertigated field crops, excessive amounts of fertilizer ingredients are often used to obtain high and good quality crop yields and to provide them with appropriate growth conditions. Such action may lead to soil salinization and contamination of groundwater with some components. In the cultivation of ornamental plants under cover, soilless substrates are most often used employing open-circuit fertigation, in which excess nutrient leaking from the root zone is discharged directly to the ground in the greenhouse/tunnel or outdoors.

An effective method of reducing nutrient losses is balanced fertilization of plants, which allows managing nutrients in a way that reduces soil and water contamination with nutrients from fertilization and increases the efficiency of their use. Such rational fertilization should be based on knowledge of the nutritional needs of plants, soil fertility (including the abundance of essential nutrients), weather conditions during the growing season, and plant cultivation technology. For this purpose, regular chemical analyses of the soil/substrate and plant material, nutrient solution and drainage water analyses are necessary.

The aim of the research is:

1. Support for producers in making decisions regarding rational fertilizer management;
2. Reduction of environmental pressure resulting from fertilizer management;
3. Verification of activities aimed at reducing water pollution with nitrates from agricultural sources and phosphorus from fertilization

MATERIALS AND METODS

The research is carried out as part of the target task 4.1 "Rational fertilization", financed by the Ministry of Agriculture and Rural Development. The established research goals are implemented through regular chemical analyzes of samples of soil/substrate, plant material, nutrient solution and drainage water collected from horticultural farms and experiments conducted at the National Institute of Horticultural Research in Skierniewice. These studies make it possible to correct the fertilization strategy of selected species in order to adjust the doses to the needs of plants while implementing strategies to reduce fertilizer consumption.

As part of the research, monitoring was carried out on horticultural farms growing cyclamen and heather. Research verifying the fertilizer needs of tulips and narcissus is also being continued on the IO-PIB experimental plots in Skierniewice. The results of observations in the cultivation of cyclamen and heather are presented below.

RESULTS

Cyclamen

On the monitored farms (in Skotnica and Osiek), cyclamen was grown on flood tables in peat substrate intended for growing ornamental plants in containers. About 2 weeks after planting, top dressing was started with a nutrient solution (fertigation) adapted to the development phase and the content of nutrients in the substrate. The results of chemical analyzes of substrates performed in individual stages of plant development indicate that the nutrient content varied, both during the vegetative growth period of cyclamen (Table 1) and during the generative growth period (Table 2) - wide ranges of the content of some nutrients in the substrate were observed (N-NO_3, Ca, SO_4^{-2}). Therefore, there was a need to correct the fertilization in the vegetative and generative phase, which allowed obtaining plants of high commercial quality (Photo 1). The observations and results obtained indicate a positive impact of the fertilization adjustments applied. The plants grew and developed properly, and no symptoms of nutrient deficiencies were observed. The limit values for the content of nutrients in peat substrate while growing of cyclamen on flood tables, proposed on the basis of the conducted research, are presented in Table 3.

Photo 1. Cyclamen (*Cyclamen persicum*)

Heather

Determining the optimal doses of fertilizers and verifying the nutrient solutions used for heather fertigation were carried out on two farms located in Wisła Wielka and Komarówka Podlaska. Samples of cultivation media and fertigation solution were collected every 4 weeks. The analyzes of the substrates (Tables 4 and 5) and the observations made indicate that the current proposed limit values for nutrients in the substrate should be verified to the following level: for the vegetative phase: pH 4.0-4.5, salinity < 1.0 g NaCl/l, 40-70 mg N-NO_3/l, 40-50 mg P/l, 80-120 mg K/l; for the generative phase: pH 4.0-4.5, salt concentration < 1.0 g NaCl/l, 30-50 mg N-NO_3/l, 20-40 mg P/l and 80-120 mg K/l. Taking into account obtained results, it is proposed to use a nutrient solution dedicated to the vegetative and generative phases for heather fertigation, with the composition shown in Table 6.

Photo 2. Heather (*Calluna vulgaris*)

Table 1. Physicochemical properties of the substrate during the vegetative growth of cyclamen.

Feature	Units	Vegetative growth		
		Range	Average	Median
pH	-	5,3 – 6,1	5,74	5,70
Salinity	g NaCl·dm^{-3}	0,27 – 1,13	0,66	0,55
N-NO_3^-	mg/l	53 – 186	112,4	94,0
P	mg/l	56 – 168	99,0	74,0
K^+	mg/l	94 – 267	179,6	172,0
Mg^{+2}	mg/l	103 – 265	164,0	154,0
Ca^{+2}	mg/l	308 – 768	532,4	542,0
Na^+	mg/l	9 – 82	30,2	22,0
SO_4^{-2}	mg/l	10,0 – 25,9	13,3	10,6
Cl^-	mg/l	17,7 – 53,0	25,5	19,6
Fe	mg/l	7,67 – 68,6	29,7	25,1
Mn	mg/l	1,21 – 7,98	4,2	3,6
Cu	mg/l	0,05 – 6,15	1,9	1,3
Zn	mg/l	0,14 – 7,85	3,3	3,1
B	mg/l	0,02 – 1,3	0,6	0,5

Table 4. Physicochemical properties of the substrate during the vegetative growth of heather.

Feature	Units	Vegetative growth		
		Zakres	Średnia	Mediana
pH	-	4,1 – 5,7	4,83	4,60
Salinity	g NaCl·dm^{-3}	0,3 – 0,6	0,47	0,52
N-NO_3^-	mg/l	16 – 59	35,3	33,0
P	mg/l	23 – 44	34,0	33,0
K^+	mg/l	47 – 117	75,3	72,0
Mg^{+2}	mg/l	90 – 130	113,1	116,0
Ca^{+2}	mg/l	382 – 501	433,6	428,0
Na^+	mg/l	27 – 55	45,9	51,0
SO_4^{-2}	mg/l	86,7 – 154	103,9	94,3
Cl^-	mg/l	37,2 – 96,3	65,4	75,2
Fe	mg/l	38,4 – 133	75,3	41,6
Mn	mg/l	6,5 – 11,4	7,5	6,9
Cu	mg/l	0,7 – 2,8	1,9	2,2
Zn	mg/l	3,1 – 7,1	4,9	5,2
B	mg/l	0,5 – 0,7	0,6	0,6

Table 5 Physicochemical properties of the substrate during the generative growth of heather.

Feature	Units	Generative growth		
		Zakres	Średnia	Mediana
pH	-	4,8 – 5,8	5,35	5,40
Salinity	g NaCl·dm^{-3}	0,2 – 0,8	0,37	0,31
N-NO_3^-	mg/l	8 – 39	18,3	14,5
P	mg/l	11 – 50	26,4	19,0
K^+	mg/l	48 – 154	82,9	70,5
Mg^{+2}	mg/l	105 – 164	140,2	146,0
Ca^{+2}	mg/l	422 – 645	515,4	506,5
Na^+	mg/l	32 – 199	71,5	60,0
SO_4^{-2}	mg/l	10 – 158	69,1	61,0
Cl^-	mg/l	20,7 – 69,2	45,3	41,9
Fe	mg/l	36,7 – 110	69,3	65,2
Mn	mg/l	3 – 5,9	4,5	4,6
Cu	mg/l	0,7 – 2	1,3	1,3
Zn	mg/l	2,4 – 6,1	4,2	4,2
B	mg/l	0,4 – 0,9	0,6	0,6

Table 2. Physicochemical properties of the substrate during the generative growth of cyclamen.

Feature	Units	Generative growth		
		Range	Average	Median
pH	-	5,1 – 6,6	5,73	5,60
Salinity	g NaCl·dm^{-3}	0,22 – 0,77	0,53	0,55
N-NO_3^-	mg/l	19 – 88	62,2	73,0
P	mg/l	49 – 125	74,2	66,0
K^+	mg/l	55 – 195	103,3	94,0
Mg^{+2}	mg/l	96 – 206	153,0	157,0
Ca^{+2}	mg/l	295 – 660	490,9	519,0
Na^+	mg/l	9 – 86	34,2	13,0
SO_4^{-2}	mg/l	10 – 100	51,4	39,0
Cl^-	mg/l	8,12 – 44,6	25,2	18,4
Fe	mg/l	20,9 – 59,6	33,6	27,1
Mn	mg/l	2,67 – 6,03	3,9	3,8
Cu	mg/l	1,41 – 6,16	1,9	1,6
Zn	mg/l	2,78 – 7,85	3,7	3,0
B	mg/l	0,01 – 1,75	0,8	0,4

Table 3. The limit values for the content of nutrients in peat substrate recommended for cyclamen fertigation in container cultivation.

Feature	Units	Development phase	
		Vegetative	Generative
pH	-	5,5 – 6,0	5,5 – 6,0
Salinity	g NaCl·dm^{-3}	0,5 – 0,8	0,5 – 0,8
N-NO_3^-	mg/l	80 – 110	60 – 80
N-NH_4	mg/l	< 50	< 20
P	mg/l	80 – 100	80 – 100
K^+	mg/l	150 – 200	100 – 140
Mg^{+2}	mg/l	140 – 160	140 – 160
Ca^{+2}	mg/l	500 – 1000	500 – 1000
Na^+	mg/l	< 50	< 50
SO_4^{-2}	mg/l	< 50	< 50
Cl^-	mg/l	< 50	< 50

Table 6. Recommended composition of the nutrient solution for heather fertigation in container cultivation for vegetative and generative growth, developed on the basis of conducted research.

Feature	Units	Development phase	
		Vegetative	Generative
pH	-	5,5	5,5
EC	mS/cm	0,9 – 1,2	0,9 – 1,2
N-NO_3^-	mg/l	40	35
N-NH_4^+	mg/l	20	15
P	mg/l	15	20
K^+	mg/l	50	70
Ca^{+2}	mg/l	60	60
Mg^{+2}	mg/l	12	12
SO_4^{-2}	mg/l	< 50	< 50
Fe	mg/l	1,4	1,2
Mn	mg/l	0,28	0,24
Cu	mg/l	0,05	0,05
Zn	mg/l	0,24	0,24
B	mg/l	0,20	0,20
Mo	mg/l	0,05	0,05

CONCLUSIONS

A detailed analysis of the results allowed to determine the limit values for the content of nutrients in the substrate. The results showed that for some nutrients it is not necessary to maintain them at a high level in the substrate when using fertigation. Therefore, an important element of rational fertilization is correcting the composition of the nutrient solution during plant growth, based on chemical analyzes of the substrate.