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The Influence of Nano-Gro® Preparation on Growth, Development and Yield of Peppermint (*Mentha* × *poperita* L.)

INTRODUCTION

Peppermint (*Mentha* × *piperita* L.) is one of the most popular herbal plant cultivated in Poland. Its raw material e.g. herb, leaves, essential oil and its main component – menthol are components of many tinctures or extracts used mainly in disorders of the digestive system. They have also astringent, antiseptic, antypyretic, antispasmotic, antimicrobial, stimulant and anti-aging properties.

The demand for above raw materials is very large therefore many years people was working on increasing the yield of peppermint and improving the quality of herb obtained from this species. It should be emphasized that the climatic conditions in Poland are conducive to the cultivation of peppermint, but there are also some dangers that make the growing of mint may be unreliable (frost in snowless winters, drought, the attack of fungal diseases, etc.). Therefore innovative solutions are quest that will avoid these risks as well as will have stimulating influence on the growth and development of plants peppermint. The answer to such goals can be modern fertilizer preparations. In addition to the effects on metabolic processes, these preparations additionally increase plant resistance to external conditions, among others, frosts, drought, salinity, disease and other infections. Such preparation is organic fertilizer NANO-GRO®, which according to the information of manufacturer's affects the growth of the aboveground part of plants and the development of the root system.

The aim of this study was to evaluate the effect of the preparation NANO-GRO® on growth, development and yield of peppermint, as well as to determine the impact of the above fertilizer on the quality of the yield of raw material (herb), i.e. the content of essential oil and its chemical composition. The impact of term of herb harvest on the tested parameters also was evaluated.

MATERIALS AND METHODS

The investigation was carried out on experimental field at the Department of Vegetable and Medicinal Plants Warsaw University of Life Sciences – SGGW (Poland) in 2014 and 2015. Seedlings for plantation establishment were prepared in a greenhouse. Rhizome-shoots seedlings were collected from the plantation located at the Experimental Field in early spring 2014 and 2015 and were placed in boxes filled with a mixture of peat and sand (1:1). In the second decade of May seedlings were planted in a field on the plots of 5m^2 in the spacing of 30×40 cm. The experiment was randomized block with 4 replications. The experimental factors were: method of application of NANO-GRO® and he term of peppermint herb collecting. Four different methods of application NANO-GRO® were used: Variant I (V1) – control – seedlings were planting in the boxes, and then (after their rooting) in the field, without the application of NANO-GRO®. Variant II (V2) – before planting in the boxes, seedlings were soaked for 60 sec. in a solution of preparation NANO-GRO®, after that rooted cuttings were planted in the field. Variant III (V3) – seedlings were planted in boxes, without soaked of solution of NANO-GRO®. When the two pair of real leaves was created, the plants were sprayed of NANO-GRO®. Variant IV (V4) – seedlings rooted in boxes, without soaked of solution of NANO-GRO®. Immediately after planting them in the field, the plants were sprayed above preparation. Solutions of NANO-GRO® for seedlings soaking and plants spraying were prepared according to the manufacturer's instructions on the package.

In each plot 5 plants were randomly selected (20 plants for each combination), for observations of morphological and developmental characteristics. Research was carried out in 4 stages of plants development: the vegetative stage (first decade of June), before flowering (third decade of June), in full flowering stage (second decade of July) and the after flowering plants (third decade of August). At any term of observation plant height, number of lateral shoots, number of leaves per plant was measure.

The first harvest of herb was carried out in the second decade of July, when the plants were at the full flowering phase. All the plants of plot (except the selected for observation) were cut down about 10 cm above the ground. The second harvest was made in the third decade of August (regrowth – the plants were in the vegetative phase). Raw material from both harvests was dried in drying chamber at 30 °C and air-dry mass of the herb was received. The results were calculated per 1 m^2. In the air-dry herb, the content of essential oil and its chemical composition were determined. The content of essential oil was determined by steam distillation, according Polish Pharmacopoeia X (2014). Separation of essential oil compounds was performed by gas chromatography.

Identified components peppermint essential oil and their percentage share [for first time of harvest, 2014]

Compound	Variant of NANO-GRO® application			
	V1	V2	V3	V4
α-pinene	0.92	0.91	0.89	0.73
β-pinene	1.21	1.22	1.19	1.08
β-myrcen	0.62	0.32	0.62	0.54
Limonene	1.65	1.69	1.81	1.47
1.8-cineol	6.29	6.64	6.34	5.05
Menthone deriv.	16.82	14.43	15.21	10.34
Menthone	22.83	21.00	19.58	17.32
Citronellal	3.42	3.24	3.13	2.91
Mentofuran	0.16	0.15	0.16	0.16
Terpinene-4-ol	3.29	3.57	2.83	2.09
Menthol	27.78	31.34	31.60	36.54
Borneol	2.17	1.84	1.98	4.91
Carvon	0.32	0.30	0.30	1.88
Percentage share of sum of all detected components	**87.48/100**	**86.65/100**	**85.64/100**	**85.02/100**

RESULTS

The influence of NANO-GRO® application and term of observation on height of peppermint plants [cm]

Variant of NANO-GRO® application	Term of observation				Mean
	First decade of June	Third decade of June	Second decade of July	Third decade of August	
V1	43.61 d[1]	47.89 cd	63.50 abc	76.94 a	57.99 A
V2	43.44 d	49.11 cd	67.44 abc	75.49 a	58.20 A
V3	40.59 d	49.22 cd	69.00 ab	74.00 a	58.87 A
V4	49.67 bcd	53.27 bcd	67.50 abc	75.18 a	61.40 A
Mean	**44.32 C**	**49.87 C**	**66.86 B**	**75.40 A**	

[1] **Means signed with the same letters do not differ significantly**

The influence of NANO-GRO® application and term of observation on number of lateral shoots of peppermint plants [pcs per plant]

Variant of NANO-GRO® application	Term of observation				Mean
	First decade of June	Third decade of June	Second decade of July	Third decade of August	
V1	0.91 g[1]	2.33 fg	4.71 cdef	6.88 bcd	3.71 C
V2	2.73 efg	4.16 def	6.41 bcd	8.71 ab	5.50 AB
V3	2.59efg	3.49 efg	5.27 cde	7.29 abc	4.66 BC
V4	3.17 efg	4.58 cdef	6.77 bcd	9.69 a	6.05 A
Mean	**2.35 D**	**3.64 C**	**5.79 B**	**8.14 A**	

[1] **Means signed with the same letters do not differ significantly**

The influence of NANO-GRO® application and term of observation on number of leaves [pcs per plant]

Variant of NANO-GRO® application	Term of observation				Mean
	First decade of June	Third decade of June	Second decade of July	Third decade of August	
V1	19.30 h[1]	33.60 gh	46.12 efg	77.24 abc	44.07 C
V2	36.12 g	53.43 def	62.78 cd	81.99 ab	58.58 B
V3	42.00 fg	46.26 efg	61.77 cde	86.82 ab	59.21 B
V4	47.67 defg	55.50 def	71.76 bc	92.70 a	66.91 A
Mean	**36.27 D**	**47.20 C**	**60.61 B**	**84.69 A**	

[1] **Means signed with the same letters do not differ significantly**

The influence of NANO-GRO® application and term of harvest on air-dry mass of peppermint herb [g×m^{-2}]

Variant of NANO-GRO® application	First term of harvest	Second term of harvest	Total mass
V1	203.33 c	636.67 ab	840.00 AB
V2	293.33 c	546.67 b	840.00 AB
V3	236.67 c	526.67 b	763.34 B
V4	260.67 c	682.67 a	943.34 A
Mean	**248.50**	**598.17***	

*** p.=0.05**

The influence of NANO-GRO® application and term of harvest on essential oil content (ml×100 g^{-1})

Variant of NANO-GRO® application	First term of harvest	Second term of harvest	Mean
V1	2.91 a	2.27 b	2.58 B
V2	2.85 a	2.37 b	2.61 B
V3	2.85 a	2.30 b	2.58 B
V4	2.76 a	2.87 a	2.82 A
Mean	**2.84***	**2.45**	

*** p.=0.05**

CONCLUSIONS

Application of NANO-GRO® significantly affects some morphological features of peppermint, for example the number of lateral shoots and the number of leaves. Under the conditions of this experiment the highest values for these parameters were obtained when the peppermint seedlings were sprayed NANO-GRO® directly after planting them in the field. In this variant the highest mass of herb was also obtained both for analyzed terms of harvest as well as for total mass. The raw material from plots where seedlings sprayed directly after planting them in a field characterized by a significantly higher content of essential oil and a high, consistent with the requirements of Polish Pharmacopoeia X (2014) participation of main component – menthol. Taking into consideration obtained results it can be said that properly chosen application of preparation NANO-GRO® in the cultivation of peppermint can increase the yield of this species and improve the quality of the herb. The recommended procedure that allows to obtain positive results is to spray rooted cuttings of this species directly after planting them in the field.