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SEEDLINGS GROWTH OF COMMON SUNFLOWER UNDER INFLUENCE OF PEPPERMINT EXTRACT

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Abstract. The aim of this study was to investigate the influence of aqueous extracts from the leaves of peppermint (*Mentha ×piperita* L.) on the seedlings and plants of common sunflower (*Helianthus annuus* L.). Different concentration of peppermint leaves extract: 1, 3, 5, 10, 15% was used to examine the growth (length), fresh and dry mass of common sunflower seedlings and plants watered peppermint extracts in phase of growth. We measured the length of seedlings and separated organs of plant: root, hypocotyl, epicotyl, petioles of the first row and remainder of the shoot. Additionally, we determined fresh and dry mass of these organs and cotyledons, leaves of the first order and remainder of the leaves. Depending on the concentration the aqueous extracts showed a stimulatory (low extract concentration) or inhibitory (high extract concentration) effect on growth, fresh and dry mass of common sunflower seedlings and plants.

Key words: allelopathy, fresh and dry mass, morphology, seedlings, *Mentha ×piperita, Helianthus annuus*

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Introduction

Growth and development of plants in natural ecosystems is modified by the physical and chemical processes resulting from the neighborhood of other plants (Sekutowski *et al.* 2012; Możdżeń & Repka 2014; Możdżeń & Oliwa 2015; Skrzypek *et al.* 2015a). Plants can react with each other in a positive or negative way, and they can constitute protection against pests and fungal diseases (Finch *et al.* 2003; Inderjit & Duke 2003). Nowadays, ecology in a common sense is a fashionable trend and a major element in the creation of organic farming, which coming back after years of application of chemical pesticides and fertilizers (Duke *et al.* 2000). According to Stokłosa (2006) an allelopathic compounds play an important role in the ecological interactions between organisms and allow their use in farming practice.

Peppermint (*Mentha ×piperita* L.) is one of the many popular aromatic plants. The species easily spreads by stolons (Fig. 1) and needs good fertilization for growth. Therefore, it should not be planted close to other perennials. According to Adaszyńska *et al.* (2013) mint oil and alcohol extract have different chemical composition. The mint oil is characterized by the highest share of menthol (24.2%), izomenthone (11.6%), isomenthol (7.9%), eucalyptol (6.1%), and menthyl acetate (5.8%). The alcohol mint extract contained menthol (34.4%), isomenthone (17.8%), neoizomentol (7.1%), and precursor of sterols – squalene, phytol, and stigmast-8 (14) -en-3β- ol.

The aim of this study was to investigate the effect of aqueous extracts of peppermint (*M. ×piperita*) leaves on growth, fresh and dry mass of seedlings and plants of common sunflower (*Helianthus annuus* L.).

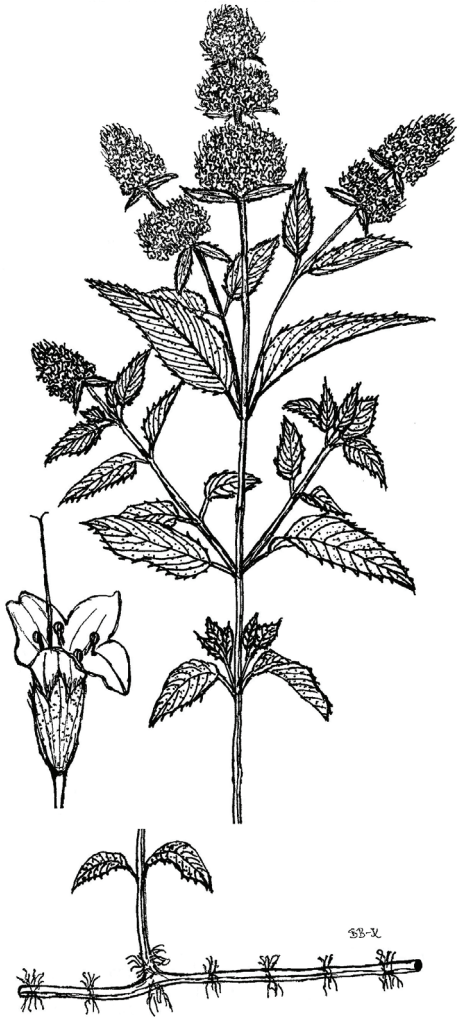

Fig. 1. *Mentha ×piperita* – shoot and inflorescence, single flower and underground stolons.

Material and methods

Material. We used the dry peppermint leaves (*Menthae piperitae folium*) from company of Flos (Morsko, Poland) and seeds of common sunflower (*H. annuus*) from company of PlantiCo (Zielonki, Poland). Aqueous extracts from the peppermint leaves in concentrations of 1, 3, 5, 10, and 15% were prepared according to method described by Skrzypek *et al.* (2015b).

Plant growth conditions. Sunflower seeds (n = 25) were placed on Petri dishes watered with aqueous extracts from the peppermint leaves of appropriate concentrations as follow: 1, 2, 3, 5, 10, and 15% and distilled water as control. After 3 days the sunflower seedlings were harvested for measurements. Besides, the seeds germinated on the distilled water were planted in sand and watered extracts from peppermint leaves by 30 days in greenhouse.

Biometric analysis. The caliper was used to measure the length of sunflower seedlings (after 72 h) and separately organs of plant (after 30 days): root, hypocotyl, epicotyl, petioles of first row and the remainder of the shoots.

Fresh and dry mass. For the determination of the fresh mass of seedlings, root, hypocotyl, epicotyl, petioles of first row, first leaves, remainder leaves and remainder of shoot for plants were weighted. To obtain a dry mass of the plant material was frozen at -80 °C and freeze-dried using a lyophilizer, and then weighted.

Statistical analysis. Statistical analysis was made using Statistica for Windows 10 (ANOVA/MANOVA) by *Tukey*'s test for n = 5, at $p \leq 0.05$.

Results and discussion

Many studies pointed out at the potential allelopathic plants in the form of extracts, decoctions (Finch *et al.* 2003; Gniazdowska & Bogatek 2005; Khan *et al.* 2005; Różyło & Pałys 2011; Skrzypek *et al.* 2015b). Aqueous extracts of *Chelidonium majus* L. with the concentrations of (2%) reduced the length and mass of wheat seedlings (Wrzesińska & Swarcewicz 2006). In our study the length of 72 h *H. annuus* seedlings, germinated on the distilled water (control test), were similar to the length of the germinated seedlings on the peppermint leaves extracts 1% and 3%. The length of sunflower seedlings decreased by half, with increasing concentration of peppermint extract (Tab. 1).

Fresh mass of seedlings decreased with increasing concentrations of aqueous extracts of peppermint compared to the control. Significant differences in the values of this

Tab. 1. Length, fresh and dry mass of *Helianthus annuus* seedlings under influence of aqueous extracts from leaves of *Mentha ×piperita* at various concentrations; the mean ± SE of 5 replicates; the values indicated by different letters (in row) are significantly different at $p \leq 0.05$ (*Tukey*'s test).

Parameter	Concentration of aqueous extracts of *M. ×piperita* (%)					
	Control	1	3	5	10	15
Length of seedlings (cm)	2.27^{a}	2.14^{a}	2.00^{ab}	1.66^{b}	1.09^{c}	0.70^{c}
Fresh mass (g)	3.64^{ab}	4.18^{a}	3.58^{abc}	3.53^{abc}	3.06b^{c}	2.82^{c}
Dry mass (g)	1.08^{a}	1.12^{a}	1.04^{a}	1.13^{a}	1.05^{a}	1.15^{a}

parameter were demonstrated at concentration of 15%. Interestingly, there were no significant differences in the dry mass of sunflower seedlings grown in the control and watered with rising extracts of peppermint leaves (Tab. 1).

Length of plant organs differed depending on the peppermint extract concentration and type of organ. In the case of root, the longest root after 30 days had the plants watered with 1% (longer then control) and the shortest: watered with 10% extract. Remainder of the shoot was the longest at the control plants and the shortest with the 10% extract. 10% extracts was the most inhibiting also for length of hypocotyl and epicotyl (Tab. 2).

Fresh and dry mass of sunflower plants differed depending on the peppermint extract concentration. The smallest fresh and dry mass were found at the concentrations of 5% and 10%. Slightly larger fresh mass values had cotyledones, petioles of the first row and first leaves in most of the extracts concentrations, relative to the organs of the control plants (Tabs 3 & 4).

Sekutowski *et al.* (2012) showed the strongest inhibitory effect on the dry mass and plant height of corn chamomile (*Anthemis arvensis* L.) and common poppy (*Papaver rhoeas* L.) after applying 10% extract from coffee grounds. The other two concentrations 2.5% and 5% extracts were characterized by significantly lower efficiency. Skrzypek *et al.* (2015a, 2015b) showed the negative effect of aqueous extracts of peppermint on germination and photosynthetic activity of common sunflower. It was stated in some studies that allelopathic compounds in low concentrations have a positive effect on the seedlings and plants growth, and high concentrations of these substances act negatively (Jankowska *et al.* 2009; Komorowska *et al.* 2012).

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Tab. 2. Length of organs of *Helianthus annuus* plants watered with aqueous extracts of *Mentha ×piperita* leaves in phase of growth. The mean ± SE of 5 replicates; values marked with different letters (in row) differ significantly at $p \leq 0.05$ (*Tukey*'s test).

Organ	Concentration of aqueous extracts of *M. ×piperita* (%)					
	Control	1	3	5	10	15
	Length (cm)					
Root	15.33^{b}	22.95^{a}	14.24^{b}	10.50^{c}	10.18^{c}	12.45^{b}
Hypocotyl	9.10^{ab}	8.90^{ab}	10.53^{a}	6.03^{bc}	5.53^{bc}	7.14^{bc}
Epicotyl	13.73^{ab}	13.53^{ab}	13.85^{a}	13.53^{ab}	8.40^{c}	11.88^{b}
Petioles of the first row	1.74^{bc}	2.00^{ab}	2.01^{a}	1.67^{cd}	1.72^{bc}	1.41^{de}
Remainder of the shoot	7.80^{a}	4.58^{b}	2.17^{cd}	4.08^{bc}	1.53^{e}	2.55^{cd}

Tab. 3. Fresh mass of organs *Helianthus annuus* plants watered with aqueous extracts from *Mentha ×piperita* leaves in phase of growth. The mean ± SE of 5 replicates; the values indicated by different letters (in row) are significantly different at $p \leq 0.05$ (*Tukey*'s test).

Organ	Concentration of aqueous extracts of *M. ×piperita* (%)					
	Control	1	3	5	10	15
	Fresh mass (g)					
Root	15.19^{a}	14.75^{a}	14.06^{b}	8.09^{d}	7.09^{e}	10.66^{c}
Hypocotyl	5.02^{b}	5.36^{a}	4.19^{c}	2.41^{d}	1.61^{e}	2.33^{d}
Epicotyl	5.07^{c}	6.01^{a}	5.13^{bc}	3.43^{de}	1.86^{f}	3.25^{e}
Cotyledons	0.36^{d}	0.92^{c}	1.50^{b}	1.51^{b}	1.50^{b}	1.64^{a}
Petioles of the first row	0.23^{c}	0.30^{b}	0.36^{a}	0.26^{bc}	0.19^{d}	0.25^{bc}
Leaves of the first order	1.87^{d}	2.49^{a}	2.43^{b}	1.62^{e}	1.35^{f}	2.02^{c}
Remainder of the shoot	2.42^{a}	1.25^{b}	1.17^{b}	1.04^{c}	0.38^{e}	0.77^{d}
Remainder of the leaves	3.33^{a}	2.63^{b}	2.70^{b}	1.85^{c}	1.06^{e}	1.65^{d}

Tab. 4. Dry mass of organs *Helianthus annuus* plants watered with aqueous extracts from *Mentha ×piperita* leaves in phase of growth. The mean ± SE of 5 replicates; the values indicated by different letters (in row) are significantly different at $p \leq 0.05$ (*Tukey*'s test).

Organ	Concentration of aqueous extracts of *M. ×piperita* (%)					
	Control	1	3	5	10	15
	Dry mass (g)					
Root	1.87^{c}	2.95^{a}	2.59^{b}	1.09^{e}	0.75^{f}	1.51^{d}
Hypocotyl	0.45^{b}	0.46^{ab}	0.35^{c}	0.16^{e}	0.12^{f}	0.20^{d}
Epicotyl	0.41^{b}	0.46^{a}	0.37^{c}	0.20^{d}	0.11^{e}	0.23^{d}
Cotyledons	0.21^{a}	0.05^{a}	0.11^{a}	0.08^{a}	0.08^{a}	0.11^{a}
Petioles of the first row	0.20^{b}	0.02^{c}	0.3^{a}	0.02^{c}	0.02^{c}	0.02^{c}
Leaves of the first order	0.21^{b}	0.24^{a}	0.23^{a}	0.14^{c}	0.12^{c}	0.20^{b}
Remainder of the shoot	0.18^{a}	0.11^{b}	0.09^{c}	0.08^{e}	0.03^{f}	0.07^{d}
Remainder of the leaves	0.43^{a}	0.34^{b}	0.33^{b}	0.19^{cd}	0.12^{d}	0.20^{c}

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