

Effect of essential oils on growth of weeds

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Introduction

The widespread use of synthetic herbicides in agriculture results in the accumulation of harmful substances in the environment, which affects human health. The search for new natural sources for weed control is an important topic in the present time (Cai and Gu, 2016; Pino et al., 2013). The potential of essential oils as bioherbicide has been the subject of intense research in recent years (Amri et al., 2013; Hazrati et al., 2018; Ibáñez and Blázquez, 2019; Nikolova and Berkov, 2018; Önen et al., 2002). Most studies in the field are limited to determine the inhibitory potential of essential oils on germination of weed seeds (Amri et al., 2017; Angelini et al., 2003; Synowiec et al., 2017). The research related to the application of essential oils on developed weeds are insufficient (Benvenuti et al., 2017; Dayan et al., 2011).

The aim of the present study was to evaluate the effect of essential oils of *Artemisia campestris* L., *Artemisia annua* L., *Thymus longedentatus* (Degen & Urum.) Ronniger and *Origanum vulgare* ssp. *hirtum* (Link) Ietsw. on growth of some weeds (*Capsella bursa-pastoris* (L.) Medicus, *Dasypyrum villosum* (L.) Borbás, *Matricaria chamomilla* L., *Sinapis arvensis* L., *Lolium perenne* L., *Trifolium repens* L. and *Trifolium pratense* L.). The essential oil profiles of the studied species were determined.

Materials and methods

Plant and seed material

Plant materials (aerial parts and seeds) were

collected from natural populations of the studied species (*A. campestris*, *A. annua*, *T. longedentatus*, *C. bursa-pastoris* and *D. villosum*) and from the *ex situ* collection of IBER (*M. chamomilla*, *S. arvensis*, *O. vulgare* ssp. *hirtum*) during the vegetation period of 2019. The seeds of *L. perenne*, *T. repens* and *T. pratense* were purchased from Florian Company.

Isolation and GC/MS analysis of the essential oil

Essential oil was extracted in Clevenger apparatus by water distillation, from dry plant material. Oil sample analyses were performed on Thermo GC equipped with a Focus DSQ II mass detector and a HP-5MS capillary column (30 m × 0.25 mm i.d., 0.25 µm film thickness). The components were identified by comparing their relative retention times with the retention times of authentic standards, and mass spectra with National Institute of Standards and Technology (NIST), of the GC/MS system as well as literature data (Adams, 2007).

In vivo toxicity test

The fifteen seeds of each weed were planted in plastic pot (8 cm diameter) filled with substrate. Pots were placed in room phytotron with average temperature 23°C and 30% humidity. The weed individuals at seedling stage were sprayed with an aqueous solution of essential oils at concentration 5 µl/mL using surfactant 0,1% Tween 40 Sigma, as an emulsifier. Seven days after spray, the treated weed plants were checked for visible injury and the dead individuals were counted. The test was repeated three times for each weed.

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Results and discussion

Essential oils of *A. campestris*, *A. annua*, *T. longedentatus* and *O. vulgare* ssp. *hirtum* were tested for growth inhibition of weeds. The essential oil composition of studied species was analyzed by GC/MS. The main compound in *O. vulgare* ssp. *hirtum* was carvacrol, while in *T. longedentatus* the predominant components were citral isomers and eucalyptol. Profiles of the other two species were more complex and no clearly dominant compounds could be outlined. Essential oil of *A. annua* contains artemisia ketone, camphor, β -pinene, camphene, eucalyptol, β -cybebene, caryophyllene oxide, caryophyllene. In the profile of *A. campestris* were identified β -pinene, α -pinene, β -ocimene, acenaphthene, eugenol.

The treatment of weed plants with an aqueous solution of the essential oils caused spots on the leaves but in the most cases, the growth resumes. *L. perrene* and *D. villosum* were found to be the most resistant. Apex yellowing was noted only on single individuals and it did not affect their growth. The toxic damage caused yellow brown spots on the leaves of *S. arvensis* and *C. bursa-pastoris*. In the samples of *M. chamomilla* a few completely destroyed individuals were observed whereas in the *T. repens* and *T. pratense* about half were died.

The essential oil of *O. vulgare* ssp. *hirtum* expressed the highest activity in comparison with all studied species. The received results confirm that carvacrol, citral isomers and eucalyptol are potent growth inhibitors (Amri et al., 2013). Furthermore, experiments with a wider concentration range of application of the essential oils should be proceed.

Conclusion

The results showed differences in weed species sensitivity to the applied essential oils. The studied representatives of fam. *Poaceae* were the most resistant.

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