THE USE OF WASTE TIRES IN RECREATIONAL AREAS AND THEIR IMPACT ON THE ENVIRONMENT

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Abstract
Hobby recreation is most often associated with activities in the countryside, consisting of plant cultivation and cottage farming in personal recreational facilities. These are often called „a second home“ which the owner together with adjacent land in personal ownership has to care for. Vacationers often make use of different means to minimize manual labour to maintain their gardens nice. One of them is the use of waste tires and products made from them. Presuming that a tire is a durable and harmless material, they apply it to the soil (rubber granulate) or use it as planting pots for growing vegetables. Such a waste tires or granulate can also appear to be a design element that can help minimize time spent in garden maintenance (water retention, weed control etc.). Although the tire seems to be a very practical product and material, it is also a waste that can be hazardous to the environment and human health due to its composition. This study evaluated the effect of waste tires microparticles using a 28-day subchronic phytotoxicity test (repeated container experiment with substrate and determined microparticle proportions of 0%, 5%, 25%, 50% and 75%) using selected plant species: *Lepidium sativum* L. and *Sinapis alba* L. The evaluation of the test showed in several cases increased phytotoxicity of the substrate after prolonged exposure of microparticles in the soil.

Key words: Phytotoxicity, pot experiment, microplastics, recreation

Introduction
The landscape, as a part of the earth's surface with a characteristic relief, includes cultural and natural elements that are influenced by man (Nassauer 2012; Act No. 114/1992 Coll. On nature and landscape protection). With the growing interest in living in recreational areas, it can be expected that the tendency of human impacts on the landscape and the environment will be set in a negative direction. One of the many impacts is the waste production. Waste tires WT (hereinafter "WT") are an example of waste whose production has been growing every year. Due to this fact we can see WT in nature in the form of illegal landfilling (Šourková et al., 2021a).
However, over the years, human attitude to the issue of have gradually changed, and in recent years we have seen efforts to reuse them (Baessler, 2022; Zafara, 2022; Wolken 2021). WT thus become quite widely used in domestic conditions, especially in recreational areas, e.g. for replacing flower pots for growing plants, for strengthening banks of driveways, or replacing vegetable mulch with rubber, etc.
Grant (2022), for example, states that the use of rubber mulch from WT has many positive properties: material resistance, moisture retention and weed permeability compared to the use of conventional bark mulch.
The whole tire, on the other hand, can be used to create mini-gardens for growing vegetables and plants. Here, too, there are several advantages. These mini-gardens are not demanding on water and fertilizers. Thanks to their black color, they absorb more sunlight – the soil heats up faster and the heat stimulates plant growth (agrifarming.in).
Due to these properties, products made from WT are marketed by retailers as a durable, safe and non-toxic material for use in the gardens of holiday homes (Brown 2019; Chalker-Scott, 2018). The question remains whether products made from WT are really safe and non-toxic to human health and the environment.
The tire must be seen as a complex product composed of many components and combined ingredients. (Prokešová, 2021). The main components (approx. 50%) are rubber polymers (synthetic and natural), carbon black (approx. 30%) and plasticizers (approx. 15%). Furthermore, the tire is composed of steel, textiles and chemical additives (accelerators, vulcanizing agents, antidegradants and activators), thanks to which it has its unique properties (Šourková et al., 2021a; Senin et al., 2016; Wik and Dave, 2005). The composition of the tire itself seems to be problematic and arguable for application to plants or growing vegetables. Another reason is the degradability of the tire, which over the years releases toxic microparticles containing polycyclic aromatic hydrocarbons and heavy metals,

thus contaminating soil and plants (Leifheit et al., 2021; Šourková et al., 2021a; Šourková et al., 2021b; William and Shenker, 2016; Wik and Dave, 2005).
The aim of this study is to evaluate the development of the toxicity of microparticles released from WT in soil, after a 6-month period.

Materials and methods

As part of the monitoring of the long-term effect of microparticles released from WT, a repeated subchronic toxicity test (so-called container experiment) was performed with predetermined procedures according to the standard ČSN EN 13432 – Determination of ecotoxic effects on higher plants (ČSN EN 13432). The substrate used in this experiment was already prepared in the study Šourková et al., 2021b, according to the European standard, which determines its given composition. It is a mixture of peat, standardized soil and silica sand. Microparticles from WT were applied to the substrate in proportions of 5%, 25%, 50% and 75% (in three replicates), including a control sample without microparticles – a total of 30 terracotta test containers. The seeds of *Lepidium sativum* L. and *Sinapis alba* L. were exposed to microparticles for 28 days and regularly watered with distilled water (DW). At the same time, the number of germinated seeds/growing plants was monitored.
After a set time, the root growth inhibition (IR) results of the plants were interpreted. IR values (%)> 110 indicate stimulation, IR values <90 indicate inhibition (phytotoxicity) and values in the range 90–110 are classified as no effect (non-phytotoxic) (Šourková et al., 2021b; Šourková et al., 2020; Baran and Tarnawski, 2013). The determination of IR (%) was given according to Equation (1):

$$\mathbf{IR = (N_T/Nc) \times 100\ [\%]} \qquad (1)$$

where N_T is the germinated seeds/growing plants in the test substrate and N_C are the germinated seeds/growing plants in the control substrate.

The experiment was terminated by dissecting the plants from the substrate. The substrate was kept in cold conditions. After 6 months, individual substrate samples, with predetermined proportions of WT microparticles (0% – control substrate without microparticles, 5%, 25%, 50% and 75%) – a total of 30 samples, were left for 3 days at room temperature 20 ± 2 °C and then reinserted into individual pots. To test the phytotoxicity, seeds of *Lepidium sativum* L. and *Sinapis alba* L. were incorporated into a substrate containing WT microparticles. For 28 days, the substrate was watered with DW and the number of germinated seeds/growing plants was monitored. After the specified time, the results were interpreted according to Equation 1.

Results and Discussion

The results were compared with the standard ČSN EN 13432 to interpret the experiment with subchronic toxicity. The initial value for comparing the results is the number of germinated seeds/growing plants in the control sample, without the addition of microparticles, i.e. IR = 100%. If the IR indicator falls below 90%, it can be stated that this is a sample having phytotoxic effects on plants (ČSN EN 13432).
The classification according to Baran and Tarnawski (2013) is used to evaluate the condition of other samples whose indicator showed values above 90%. This indicates that an indicator showing values above 110% (IR (%)> 110) classifies a sample with stimulating effects on plants. Indicator values in the range of 90–110% are classified on the basis of germinated seeds/growing plants as non-phytotoxic (no effect).
The range of IR values in the subchronic toxicity experiment for 28 days was between 61%–92% (out of control, IR = 100%), see Figure 1. Based on the results of the study, it was found out that substrates containing 5% of microparticles were the only ones to show no effect (non-phytotoxic/no effect). on *Sinapis alba* L. (IR = 92%) and *Lepidium sativum* L. (IR = 91%). Substrates containing 25%, 50% and 75% of microparticles were evaluated as phytotoxic based on IR values of germinated seeds/growing plants of *Sinapis alba* L. and *Lepidium sativum* L. Thus, we can state that with increasing amount of microparticles released from WT, the adverse impact on plants increases due to the action of phytotoxic substances (Šourková et al., 2021b; Block et al., 2019).
The same experiment was carried out by Šourková et al., 2021b. Figure 1 presents the results of this study and compares it with the study performed in 2021, where the subchronic phytotoxicity of WT microparticles was evaluated 28 days after incorporation into the substrate. To monitor the further development of phytotoxicity, the soil with the microparticles, was left (aging of the soil sample) in a cooling box for 6 months. Subsequently, the medium was used to test the phytotoxicity and to monitor possible changes in IR values. *Sinapis alba* L. (I.) and *Lepidium sativum* L. (I.) represent the final

growth inhibition values in the study Šourková et al., 2021 and *Sinapis alba* L. (II.) And *Lepidium sativum* L. (II.) represent final values in this study.

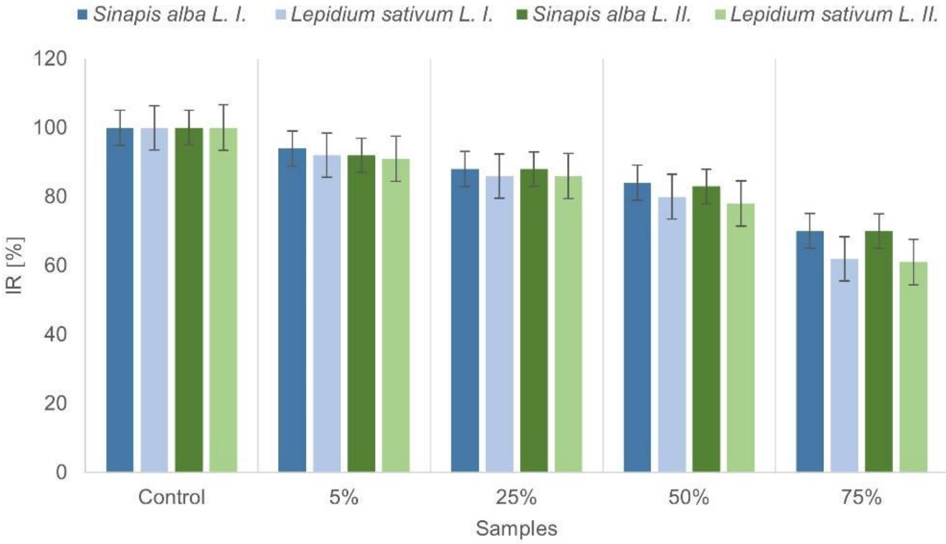

Fig. 1: Final growth inhibition values *Sinapis alba* L (I.) and *Lepidium sativum* L. (I.) in experiment by Šourková et al., 2021b and *Sinapis alba* L (II.) and *Lepidium sativum* L. (II.) after repeated testing (after 6 months).

It was found that the long-term occurrence of WT microparticles shows a slight increase in phytotoxicity (growth inhibition), i.e. a decrease in IR values, in some samples. Specifically, these are samples of substrates with 5% of microparticles with *Sinapis alba* L., where growth inhibition increased by 2.1%, and substrates with 50% of microparticles with *Sinapis alba* L., where there was an increase of 1.2%. Then there are samples of substrates with *Lepidium sativum* L. with a 5% proportion of microparticles, where the growth inhibition increased by 1.1%, and with a 50% proportion, where there was an increase of 2.5% and with a 75% proportion of microparticles, which showed an increase in growth inhibition by 1.6%. The other samples showed the same values as in the experiment carried out 6 months ago.

The use of WT in recreational gardens and also outside of them may be associated with an increased risk to the environment. Systematic research into the impact of WT on individual components of the environment is needed. In addition to existing standards and regulations, a quantitative analysis of the environmental impacts of tires over the whole life cycle is extremely important for understanding sustainability in the tire industry. Further research is required.

Conclusion

The aim of this study was to evaluate the development of the toxicity of microparticles released from WT remaining in the soil for 6 months. Based on the results of this research the phytotoxicity of a substrate containing 25%, 50% and 75% of microparticles was demonstrated, therefore it is not appropriate to use the products from WT or the WT themselves as a decorative element in gardens or for growing plants and vegetables.

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Souhrn
Tato studie hodnotila dopady využití odpadních pneumatik a výrobků z nich v zahradách rekreačních oblastí. Pomocí subchronického testu toxicity byl zhodnocen vývoj působení mikročástic z odpadních pneumatik v substrátu, připravený v laboratorních podmínkách. Bylo zjištěno, že chronická přítomnost mikročástic v substrátu, stále uvolňuje látky, které působí toxicky na pěstované rostliny. Tyto částice s sebou tak mohou nést rizika pro životní prostředí i zdraví člověka.

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