

Recommendations on safety of composting or use as biogas fuel of common ragweed seed contaminated material



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Introduction

Common ragweed (*Ambrosia artemisiifolia*) seeds are often found as a contaminant of different commodities, such as agricultural products (e.g., sunflower seeds), or of soil transported for construction purposes. The movement of these commodities may consequently become a pathway for the introduction of common ragweed to new areas (e.g., EFSA 2010).

In addition mechanical control measures like mowing, mulching or tillage, may yield plant material that contain viable seeds. Even after herbicide treatments with good efficacy viable common ragweed seeds can survive that and may be transported with human activities. When this plant material cannot remain in the habitat, ways of disposal are needed that are free of the risk of dispersing the seeds, but are at the same time environmentally friendly and lawful. Incinerating the material, for example, may not be lawful and creates emissions. Composting or disposing of the material in biogas plants, however, may result in residue containing viable seeds thus enhancing the risk for dispersal.

Maize is the most commonly used feedstock for biogas reactors in Germany (Westerman *et al.*, 2011). If common ragweed seeds are able to survive the biogas process, this can result in another pathway of dispersal from field to field.

Before the project no detailed information was available on the ability of common ragweed seeds to survive the composting or biogas processes. Experiments on composting in the EUPHRESKO project AMBROSIA had failed to produce consistent results (Holst, 2010). In an earlier experiment with biogas fermenters the Tetrazolium test had produced ambiguous results (Heiermann *et al.*, 2010). There was also no information on temperatures that common ragweed seed can survive.

Ripening of common ragweed seeds after cutting the plants

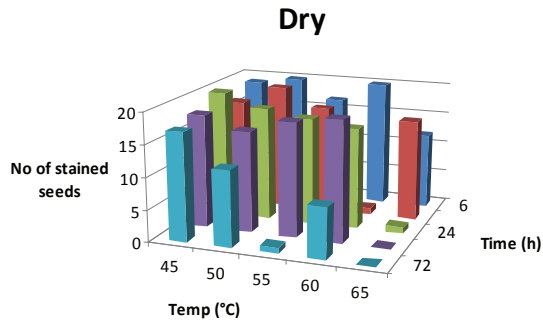
After the application of mechanical control measures, like mowing or mulching, remnants of cut plants may contain seeds already viable or finishing ripening process. In order to obtain information about the ripening process of seeds from plants cut at different postfloral stages trials in Austria and Germany were conducted, please see article 3 in Section A of this report.

Impact of heat treatments on seed viability

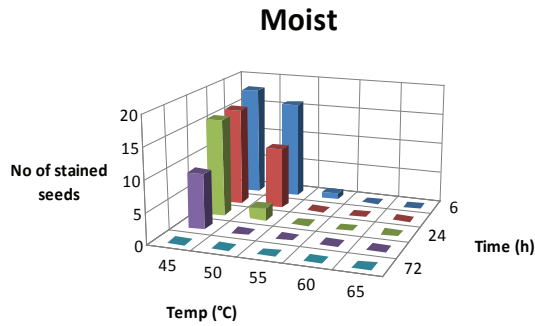
In order to recommend safe disposal of material potentially containing common ragweed seeds we conducted several series of basic laboratory experiments to determine the physiological limits of heat tolerance.

Experiment A

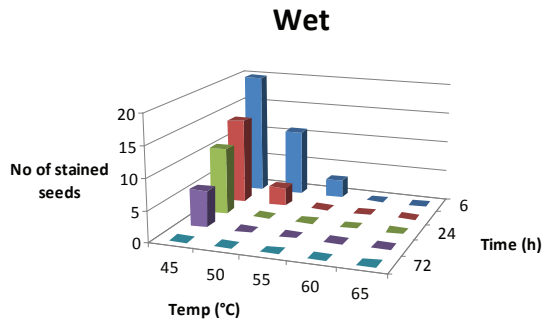
Common ragweed seeds were exposed to temperatures between 45 and 65 °C for periods of 6 to 72 hours in wet, moist, and dry conditions. Results are shown below.



a)



b)

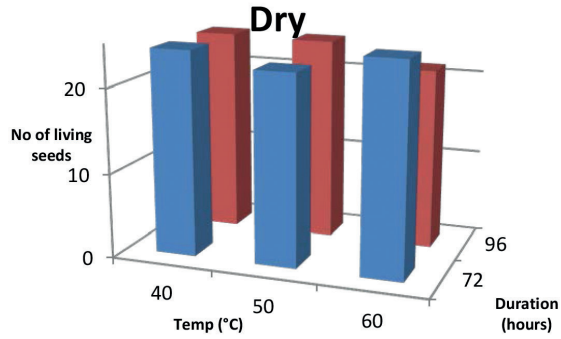


c)

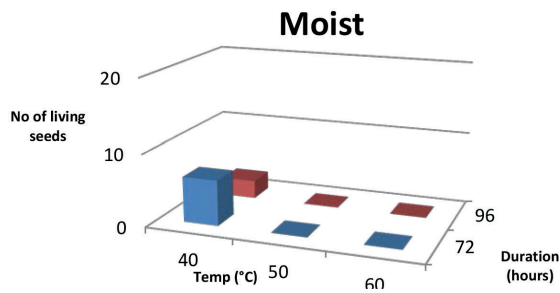
Fig. 1: Results of Experiment A: Number of common ragweed seeds surviving (out of 20) temperatures between 45 and 65°C over 6 to 72 hours under dry (a), moist (b) and wet (c) conditions

Experiment B

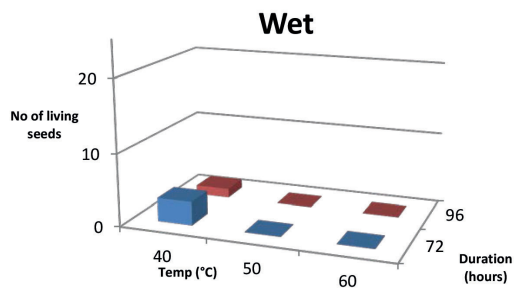
Common ragweed seeds were exposed to temperatures of 40°C, 50°C and 60°C for 72 and 96 hours in wet, moist, and dry conditions. Results are shown below.



a)



b)

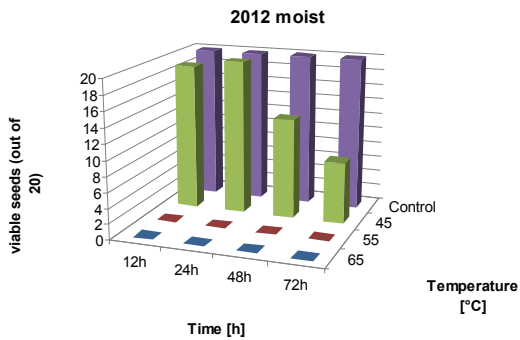
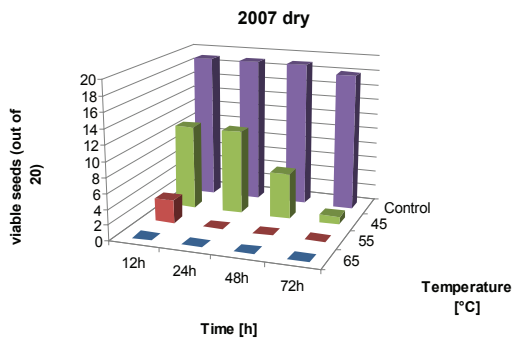
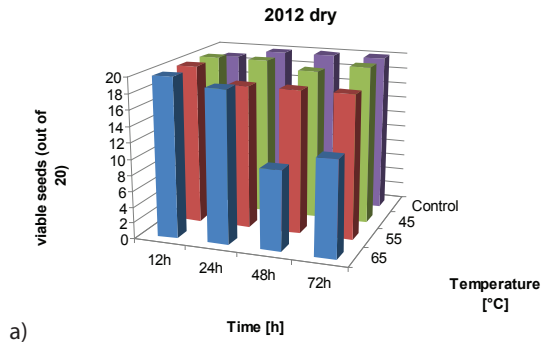


c)

Fig. 2: Results of Experiment B: Percentage of seeds surviving temperatures of 40, 50, and 60°C over 72 and 96 hours under dry (a), moist (b) and wet (c) conditions.

Experiment C

Common ragweed seeds were exposed to temperatures of 45°C, 55°C and 65°C for 12, 24, 48, and 72 hours in wet, moist, and dry conditions. Seeds of different ages: one year old (harvested in 2012) and 6 years old (harvested in 2007), were tested. Results are shown below.



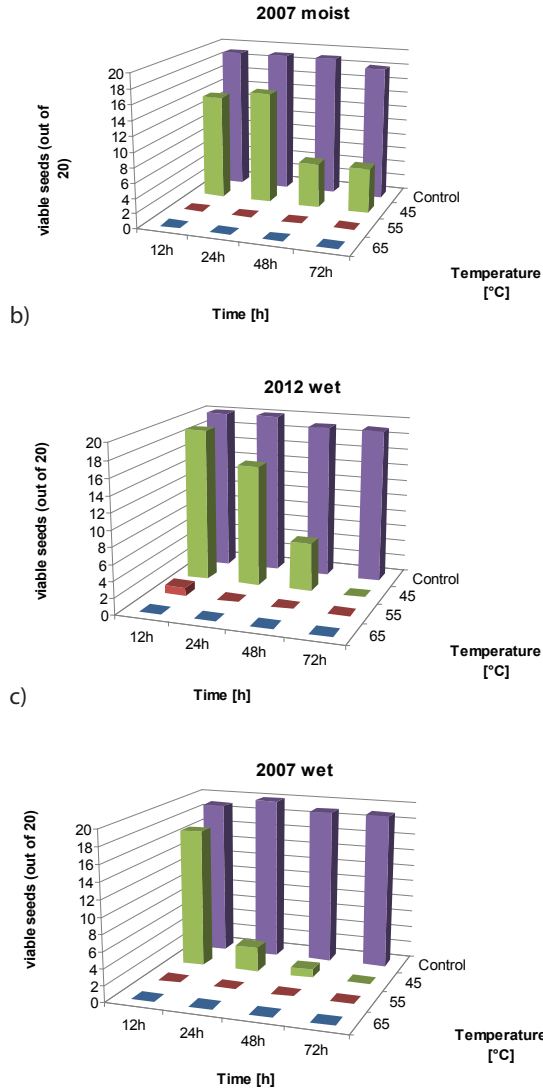


Fig. 3: Results of experiment C: Percentage of seeds of different age surviving temperatures of 40, 50, and 60°C over 72 and 96 hours under dry (a), moist (b) and wet (c) conditions. Left column: Young seeds (2012), right column: Older seeds (2007).

Result

The ability of common ragweed seeds to survive heat strongly depends on their condition:

- Dry seeds can have survival rates of 80 % after 72 and 96 hours
- Moist and wet seeds are reliably killed after 36 hours at 50°C or after 24 hours at 55°C.
- Both the viability and the ability of seeds to survive heat is reduced in older seeds.

Impact of the biogas process on seed viability

Seeds were tested in an experimental biogas fermenter (batch) at the Julius Kuehn-Institute. The fermenter was run at 37°C and shaken twice daily, the fermenting matter consisted of digestate taken from a biogas plant and water in a ratio of 1:1. Untreated seeds were stored in the fermenter for 1, 2, 4, 8, 16, and 32 days before being tested for viability with the TTC test. Some seeds were exposed to different silage processes (green rye and maize with and without additives) for 3 month, which is the normal time span for the silage process, before being tested for viability. Results are presented below (Fig. 4).

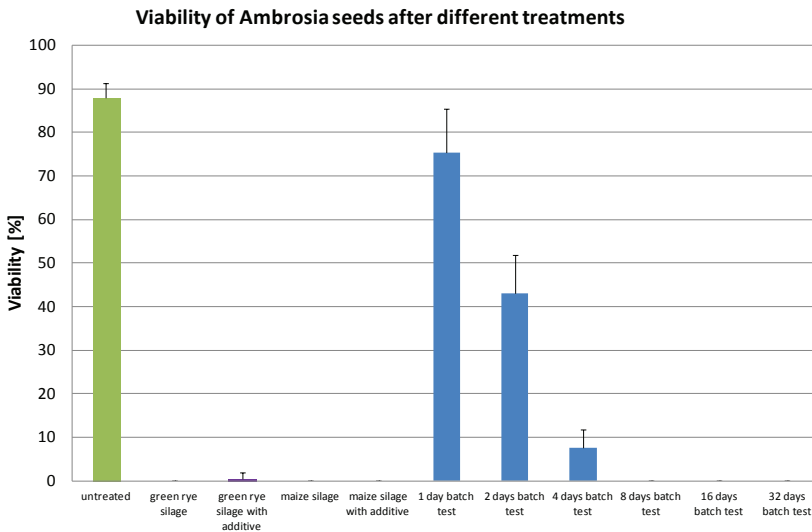


Fig. 4: Viability of common ragweed seeds after different treatments (3 month silage; 1, 2, 4, 8, 16, and 32 days in fermenter)

Ragweed seeds were also tested for germinability after exposure to a simulated biogas fermenter in an Austrian experiment (Gansberger 2011). Here, after 1 day a germination rate of 9% was found, but 0% after three days.

A series of experiments on weed seed survival in the biogas process is described by Westermann (2010).

Impact of the composting process on seed viability

As experiments in composting units were done in Austria and published after the start of HALT AMBROSIA and because our basic laboratory experiments on survival of heat stress are available, we did not conduct own experiments in composters. In the Austrian experiments (Hackl and Baumgarten, 2011), common ragweed seeds were put into polyethylene seed bags that were introduced to two types of commercial composters and at three depths (30, 60, 90, and 120 cm). The experiments were run for different lengths of time. Seeds were placed on filter paper and on water agar at 20°C/30°C (night/day) and 12h of light. Germinated seeds were counted after 7 and 21 days. In all seed lots 0 % germination was found at the first time, i.e. 10 days. In these two types of composters, temperatures of 55-60°C, and 65-80°C, respectively, were reached. The authors conclude that commercial composters are a safe way of disposing of plant material that contains common ragweed seeds, because the seeds lose their germinability.

In the Austrian experiment only a germination test was used as compared to the Tetrazolium seed viability testing applied in our experiments. The same is true for an older German study which recommended a safe disposal of common ragweed seed in composters (BGK, 2007).

A germination test alone may underestimate seed viability as dormant seeds that are viable may not germinate. The results must therefore be seen in relation to the results of our heat treatment experiments described above.

Conclusion and recommendations

Management measures against common ragweed populations may yield material that contains viable seeds. When this plant material becomes transported and disposed of without being treated in a way that reliably kills the seeds the risk of dispersal and of developing new common ragweed populations in uninfested areas arises. Management measures that aim at reducing common ragweed populations may thus miss their aim.

In general, management methods should be preferred that do not yield plant material with ripe or ripening seeds, e.g. mechanical control measures like uprooting or cutting before the onset of (female) flowering. If this is not possible, plant material resulting from mechanical control measures should remain on the site in order to avoid spillage of seeds during transport.

The example of Switzerland, where common ragweed is controlled effectively by now, demonstrates that it is necessary to increase awareness of the common ragweed problem in the building sector.

In Switzerland a special legal obligation regarding the disposal of excavated material contaminated with organic material (Neobiota) exists in the canton Zürich. The regulation says: If an invasive plant species occurs at a construction site the building owner has to fill in a declaration. Contaminated soil that cannot be used at the site has to be disposed at authorized sites.

During the construction work the contaminated material must not be mixed with clean material and it has to be separated. During the excavation a consultant has to be present at the construction site. It has to be ensured that no contaminated material is lost during the transportation. After transportation to the disposal site a form with a report has to be sent to the authorities. 1-2 month after the measure an authorized consultant has to control whether invasive plants grow back at the site.

However, there may be situations in which plant material with ripe seeds is created that cannot remain onsite. For this type of plant material, a disposal in composting or biogas facilities may be recommendable as seed viability can be destroyed by thermal and chemical conditions of treating facilities.

A recommendation for the disposal of material containing common ragweed seeds can only be given when the following conditions are met:

- During collecting and transport of the plant material, care must be taken not to spill common ragweed seeds. This may be achieved by using closed containers (e.g., plastic bags) and closed vehicles.
- The material must stay for 10 days in the biogas reactor. This is generally achieved in batch reactors but not in CSTRs (Continuous Stirred-Tank Reactor, like: single-stage, continuous flowthrough, stirred tank reactors) (Westerman *et al.*, 2010). For CSTRs, only previously ensiled material can therefore be safely used.
- In our experiments, 55°C for 36 hours was enough to kill the seeds. In order to increase the reliability of all common ragweed seeds being killed, composters should reach 55° C for three weeks or 65° C for one week and the temperature should be monitored (cf. Schmid, 2007).
- Only industrial/commercial composting facilities can be recommended – not a private garden compost heap!
- Cutting and post ripening: safe only until the early female flowering (BBCH 63) if cut plant material is left on the soil surface

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