Efficacy report and guidance on options for thermal control of *Ambrosia artemisiifolia*

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DOI 10.5073/jka.2016.455.20

Introduction

Thermal weed control is an alternative treatment where neither chemical nor mechanical control is allowed or possible. Research activities are needed to develop innovative control systems especially for non-cropping areas because herbicide uses are very restricted within the EU. Since *Ambrosia artemisiifolia* is also spreading in organically grown fields there is a strong demand to provide alternatives for organic farmers. The principle of thermal control is that temperatures above 60°C in the plant cells lead to nucleic acid denaturalization. This impact causes an irreversible damage of the plant tissue and leads to necrosis. Machinery for thermal weed control is working with flames, infrared or heated air and heated water (steam or boiling water) and hot foam, which is applied on the plants.

Materials and Methods

Based on pre-trails in 2011, two experiments on thermal control of *A. artemisiifolia* plants were conducted from June 2012- October 2012. Small plot (2x3 m) field experiments at the experimental site at JKI with transplanted *A. artemisiifolia* in gravel and grassland (10 plants per treatment, each plant was a replication). Furthermore, a large scale field experiments (0.80-1.50 x 50 m, 4 replications) on a rural roadside banquette in Brandenburg with a natural *A. artemisiifolia* infestation were carried out.

The following treatments were conducted in comparison with untreated plots:

- Thermal: Flaming 600°C (Green-Flame 850 E, Green-Flame, Vordingborg, Denmark)
- Thermal (in gravel and grassland only): Hot Air 370°C (Combi Compact, Adler Arbeitsmaschinen, Nordwalde, Germany)
- Thermal (at the roadside banquette only): Hot Water 99°C (Wave High Series hand unit, Wave Europe, Wekerom, Netherlands)
- Mechanical: mowing (with a brushcutter in gravel and grassland and with a self-driving mower by road maintenance staff at the roadside banquette)
- Chemical: Herbicide application with a hand unit (6L Banvel M /ha: 30 g Dicamba /L and 340 g MCPA /L)

The transplanted *A. artemisiifolia* plants in grassland and gravel were treated at BBCH 14-16 and 18-24 at the end of July (Table 1).

5 weeks after the treatments took place, half of the plots were mown. The roadside banquette trial was conducted at BBCH 50-65 of *A. artemisiifolia*, also at the end of July.

4 weeks after the last treatment dry matter of the remaining *A. artemisiifolia* plants in gravel and grassland and on a 0.25m^2 area at the roadside banquette were determined.

The statistical analysis was carried out with STATGRAPHICS Plus 5.1.

Table 1: experimental lay out

Habitat:	grassland and gravel	roadside banquette
BBCH stage at treatment:	14-16 and 18-24	50-65
1. treatment:	Flaming, Mowing, Herbicide Hot air	Flaming, Mowing, Herbicide Hot water
2. treatment:	Half of the plots were mown 5 weeks after 1. treatment	-
Harvest of Ambrosia DM:	4 weeks after 2. treatment	4 weeks after 1. treatment

Results

The results of the gravel and grassland experiment showed that *A. artemisiifolia* dry matter in grassland was significantly reduced by thermal control at BBCH 18-24 (Figure 1). In gravel thermal control by hot air at BBCH 18-24 led to significant lower *A. artemisiifolia* dry matter than the control, flaming however, seemed to stimulate plant growth. Flaming and hot air at BBCH 14-16 reduced significantly dry matter in grassland respectively in gravel.

Plots that had a second treatment by mowing 5 weeks after the first treatments showed very low *A. artemisiifolia* dry matter of less than 0.5 g per plant in average in all treatments This successful second treatment was independent of the kind of the first treatment (data not shown).

The herbicide treatment resulted in a complete eradication of the *A. artemisiifolia* plants in grassland and gravel, both in the plots with the first treatment only and with the second treatment, too.

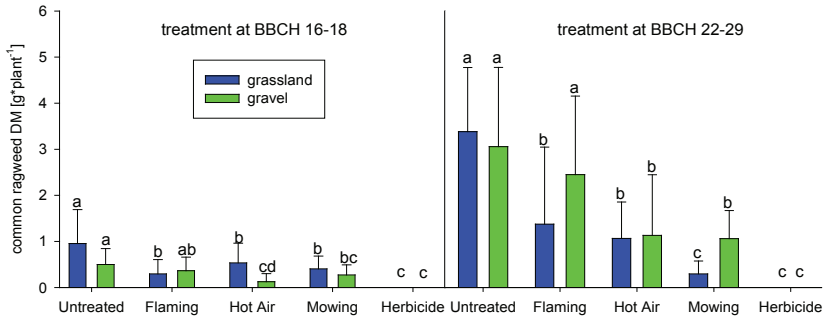

Fig. 1: *A. artemisiifolia* DM [g*plant-1] in grassland and gravel 9 weeks after treatment, columns of the same colour with different letters differ significantly at P<0,05, bars indicate standard deviation

The results of the roadside banquette trial showed that the thermal control treatments flaming and hot water led to significant lower Ambrosia dry matter than the control (Figure 2). The hot water treatment had the lowest DM which differed significantly from flaming. The following order of the treatments point out the best eradication: Hot Water > Mowing > Herbicide > Flaming.

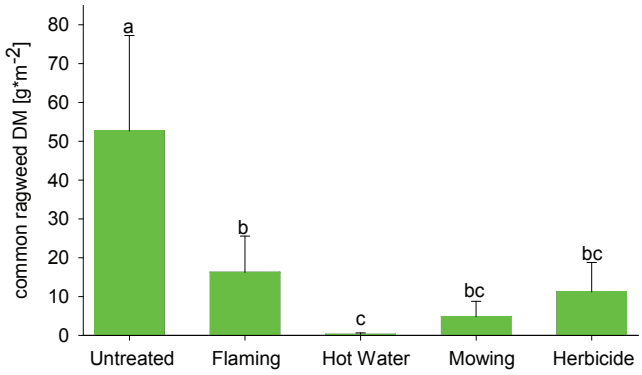

Fig. 2: *A. artemisiifolia* DM [g* m^{-2}] at roadside banquette 4 weeks after treatment, columns with different letters differ significantly at $P<0.05$, bars indicate standard deviation

Discussion and Conclusions

The results of these experiments demonstrated the efficiency of thermal control methods based on hot air and hot water. Recent investigations in Germany and other European countries could also identify hot water systems as a promising tool (Dittrich *et al.,* 2012; Rask *et al*., 2007). They concluded that at least 2 applications are necessary for a successful weed control. In general the hot water control is applied up to 4 times during the vegetation period but in our studies was carried out one time only with very promising results. However, there are still gaps of knowledge in terms of the dose-response relation for Ambrosia (e.g. propane consumption in kg/ha) and also correct timing of the application is often difficult (Ascard, 1995). Investigation of the earlier Euphresco project on Ambrosia clearly pointed out the low competitiveness of Ambrosia (Holst *et al*., 2010). Therefore any direct control method should be as selective as possible to inhibit growth of Ambrosia by the competition of the surrounding vegetation. Despite its high regrowth capacity , there are no indications that Ambrosia is less susceptible against heat treatments like most of other weed species. Additional information is still required to develop a more specific guidance which enables the practical implementation. Focusing on eradication of Ambrosia we should know more about heat effects on seed viability in non-cropping areas. A critical point of thermal control methods is the high energy input corresponding with high costs. This will require an economic evaluation specified for different uses and scenarios.

References

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