



**Weed biocontrol and cover crop termination with alternative natural compounds**

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**Introduction**

Essential oils (EOs), as pure natural compounds or in mixtures, are considered good candidates for the development of new bioherbicides (Verdeguer et al., 2020). Another valid bioherbicide is the primary component of vinegar, the acetic acid, which can destroy cell membranes, inducing plant tissue desiccation and plant death (Kremer, 2018).

The aim of the present work was to identify possible alternative treatments for weed control and cover crop termination by using less harmful compounds than glyphosate based herbicides.



90 days after treatment

No treated control

**Materials and Methods**

Weed control trial was carried out in a green roof located at the Department of Agricultural and Food Sciences (University of Bologna, Italy). The fully randomized experimental design with 3 replicates included the following treatments: concentrated natural vinegar (10 and 20% in acetic acid) (AN), glacial acetic acid (10 and 20%) (AA), clove EO (1.5 and 3% in eugenol) (EU), lemongrass EO (1.5 and 3% in geraniol) (GE), glacial acetic acid (10 and 20%) plus 1.5% of eugenol and geraniol (MIX), glacial acetic acid (10 and 20%) plus 25% of residues of balsamic vinegar barrel plus 0.15% of chitosan (ACT). The treatments were applied at the volume of 850 L/ha. Visual weed cover and control ratings were collected 7 and 28 days after treatment (April 28, 2021).

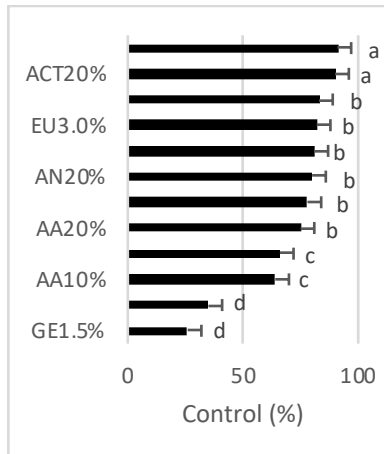
The field experiment were carried out in two farms of the Bologna University. The experiment was designed as a randomize complete block design, with 3 replicate blocks. Cover crops (mix of *Avena sativa*, *Vicia sativa* and *Vicia villosa*) were planted on October 9, 2020. By mid-April, when the oat was at the middle of the heading stage and the vetch at the elongation stem stage, cover crops were treated, applying 150 L/ha as spraying volume, with: a) glyphosate (360 g/L) at 5 L/ha as application dose, only in the conventional farm; b) glacial acetic acid (10% v/v); c) vinegar concentrate (acetic acid 10%); d) vinegar concentrate (acetic acid 10%) plus 1% v/v clove EO; e) vinegar concentrate (acetic acid 10%) plus 1% v/v lemongrass EO; f) white vinegar concentrate (acetic acid 23%). After 3 weeks, cover crops were incorporated into the soil with a disc harrow to a 20 cm depth, with two passes.

**Results**

The green roof experiment had very high weed densities with multiple grass and broadleaf weed species. The mean weed density per plot was  $1987 \pm 487$  (plants  $m^{-2}$ ). The average weed cover percentages were 98% total weeds, 27% grass, 63% broadleaf weeds. The most abundant broad leaf species were *Oxalis corniculata*, *Cersatium ramosissimum*, *Gallium aparine*, *Erigeron canadensis*, *Trifolium arvensis*, while the most common grasses were *Poa annua*, *Poa trivialis*, *Setaria italica*, *Anisantha sterilis*. Total weed control ranged from 0% control (no acetic acid - untreated control ) to 91% control 28 DAT (glacial acetic acid 20% plus 1.5% of eugenol and geraniol) (Figure 1). In general, all the treatments were more effective in controlling broadleaf weeds than in controlling grasses. For all the treatments the efficacy significantly decreased at 28 DAT (ranging between -20 and -43%) with respect to that observed 7DAT. Optimal total weed control occurred with 20% acetic acid applied in combination with EOs (MIX20%) or with chitosan and residues of balsamic vinegar barrel (ACT20%). The EOs at the lowest concentrations (EU1.5% and GE1.5%) exhibited the worst performance in controlling total weeds. Efficacy of cover crop termination methods were reported in Table 1. Glyphosate was the most effective method of terminating cover crops (97%). Alternative treatments to glyphosate have shown reduced effectiveness, ranging from 5% (respectively for vinegar concentrate and vinegar concentrate plus 1% v/v clove oil) to 25% observed in the plots treated with white vinegar concentrate.

Type of termination	Conventional farm	Organic farm
Glyphosate	97% (a)	--
Glacial acetic acid	10% (c)	--
Vinegar concentrate (acetic acid 10%);	5% (c)	5% (b)
Vinegar concentrate (acetic acid 10%) plus 1% v/v clove EO	5% (c)	5% (b)
Vinegar concentrate (acetic acid 10%) plus 1% v/v lemongrass EO	10% (c)	15% (b)
White vinegar concentrate (acetic acid 23%);	25% (b)	25% (a)

Table 1. Efficacy of cover crop termination methods as percentage of dead vegetation on the total green cover



**Conclusions**

The results confirmed the potential of acetic acid at a concentration of 20% in combination with EOs in controlling a broad range of weed species. However, the same treatments applied for cover crop termination failed: additional research effort is required for tuning the desiccation of cover crops with tested natural compounds.

Furthermore the trial allowed to highlight the critical issue of the treatments: high insolation levels and high temperature limit the efficacy of treatments; bioadhesive agents allows more effective treatments; micronization allows more effective treatments; better control of dicotyledon in front of monocotyledon.