Evaluation of Acetic Acid as a Thistle Top-killer on Pastures

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Background and Objective:

Evaluations under the USDA Sustainable agriculture program indicate that acetic acid solutions (5 to 20%) effectively kills a number of weeds (USDA, 2003). Canada thistle shoots are among the most susceptible. I tested this on Bull thistle and Canada thistle at varying growth stages on NSAC dairy/sheep pastures, to determine if acetic acid would be an effective option for top-killing thistles. I also tested two application methods for effectiveness and non-target kill.

Methods:

Four thistle types were sprayed using an inexpensive compressed air sprayer with solutions of 5, 10, or 20% acetic acid made from pure acetic acid (Fisher Scientific, ACS grade). In all applications, top growth was thoroughly wetted with spray. Sprays were applied on August 28, 2002. In addition, acetic acid was applied to young Canada thistle using a wick-type applicator. The wick applicator was a commercial product, and consisted essentially of a piece of poly pipe about 1 M long, enlarged at the base with cord wicks forming a pad at the bottom, about 8 cm diameter at the base. The pad stayed wet with acetic acid solution from the pipe. Acetic acid was applied by stamping low growing thistle re-growth with the wick to attempt to wet all the foliage.

The following thistle types were sprayed:
1. Young pre-bud Canada thistle that had been clipped twice in the summer, about July 1 and Aug 1 - young and vegetative, less than 20cm high.
2. Canada thistle in bud or early flower, that had been clipped about July 1 - semi-mature 20 to 50 cm tall.
3. Bull thistle in early flowering, having been clipped about July 1 - 20 to 50 cm tall.
4. Vegetative 1st year Bull thistle rosettes.

I later sprayed a considerable area of young Canada thistle using an 8% solution of acetic acid, to obtain top kill of thistles on pasture that had previously been clipped. (mid-September.)

Types 1, 3 and 4 were located along the southern 1/3 of the 'white fence field' of the NSAC Boulden pastures, more or less in front of the yard in front of the College machinery shed.
Type 2 were located in pasture field 130C, the native grass interval pasture below the Boulden pastures. In the interval field, thistles were infested by one of the pests of Canada thistle that is recommended as a biological control, judging by numerous galls on

the stems, but these pests were apparently not an effective control since the thistle infestation was extensive.

Thirty thistles or clumps of thistles of each type were sprayed, 10 of each being sprayed with each of the concentrations of acetic acid. In addition, two first year Bull thistle, in the rosette form, were sprayed, one with 5% and one with 10% solution.

Thistles were photographed two days following spraying, and observed periodically over the next 20 days to visually evaluate burn-down and non-target damage.

Observations:

Bull thistle: Bull thistle was consistently killed within 2 hours with 10 or 20% solutions. A 5% solution caused partial burn-down - about 50% brown leaves. In all cases, only tissue contacted by the solutions was browned, and there was usually a small fraction, about 5%, of leaves that were missed. In Bull thistle, there was considerable non-target kill at the 10-20% rates, but minimal peripheral kill at 5%. At higher concentrations, the areas around the thistles were largely killed. Rosettes of first year bull thistle were completely killed with 10 or 20% solutions, but there were only two examples.

The thistle on the left was unsprayed. The thistle on the right was sprayed a few hours previous with a 10% acetic acid solution. It did not re-grow in 2002.

Young Canada thistle: Younger Canada thistle was burned down with efficacy similar to Bull thistle – i.e. moderate burn-down at 5% and complete burn-down at 10-20%. Thistle that was sprayed with 8% solution in mid-September exhibited no re-growth by mid-October.

Young Canada thistle sprayed with 5% acetic acid solution a few hours previously. Note live dandelion leaves that survived the treatment.

Older Canada thistle: Control of older Canada thistle was poor. After 7 days or more, thistles were partly green even after spraying with the 20% solution. The 5% solution had relatively little effect. The 10% solutions caused minor burn-down and the plants mostly recovered within 2 weeks.

Maturing Canada thistle sprayed a few hours previously with 20% acetic acid. This field had been clipped earlier in the summer. (Aug. 28 photo.)

Wick weeder: Application of an 8% acetic acid solution to young thistle using the wick-weeder was not effective. I obtained poor coverage and only some leaves were killed. The wick weeder was also much slower to use, and used more solution than the sprayer because it tended to drip between thistles, or run too fast when newly filled. A different design might perform better.

Non-target kill: Solutions of 10% or more acetic acid caused over 50% kill of grass and clover near the thistle base – usually within 10 cm or so of the target plant. The grass and clover showed re-growth after about 2 weeks. Where thistle kill was complete, no thistle re-growth was observed over 20 days.

Target and non-target kill by a 20% solution of acetic acid sprayed on young Canada thistle. Note a live dandelion leaf in the center of the picture.

White clover re-growth 7 days after spraying with a 10% solution of acetic for thistle control.

Other plants:

I sprayed a few dandelions with 10% acetic acid at edges of my home garden. Repeated applications caused some browning of the leaves, but did not kill the dandelion. I sprayed a few dandelions on the college pastures with a 20% spray. This killed some leaves where coverage was good, but not consistently, and did greater damage to surrounding grass and clover. So, I conclude that vinegar is not useful for killing dandelion. Any grasses or clovers (young and leafy) I sprayed were readily top-killed with a 10% acetic acid solution, and were considerably suppressed with a 5% spray.

In late May 2003 I sprayed grass around some water taps that we have along fence lines in the pastures, using a 10% acetic acid solution. Some of the younger leafy grass was killed, but most of the grass survived this treatment.

In early June 2003, I sprayed young dandelion in a wet section of my home garden that had not been turned over yet, with a 20% acetic acid solution. This effectively killed the dandelion, but did not affect some bent grass that went on to head out after a few days, on a piece I did not till. The dandelion sent out new shoots within a week or so.

Costs: I used about 10 liters of an 8% acetic acid solution to spot spray about 400 meters of fenceline, where young Canada thistles were scattered over an area 1 or 2 meters wide. Using my source of standard laboratory acid, the cost of this amounts to about $15. (@ $18 per liter for pure acid.) USDA (2003) suggests US $22 per acre for band spraying corn with 20% acetic acid vinegar, or US $66 for complete coverage with 20% acid.

Acetic acid at 5 to 10% is a useful option for thistle control a few weeks following clipping of Canada thistle. Clipping or top killing Canada thistle actually increases the number of thistles when they re-grow from the creeping part of the roots. . (i.e. – if you cut one, three will grow back from the roots – and it is not practical to remove all the roots.) However, repeated clipping eventually weakens the roots until the thistle dies. Later in the season, the re-growth remains fairly short, and clipping will usually leave some green leaves. Acetic acid application in August/September provides an easier option to control this short re-growth.

On tall thistle, it is easier and more effective to clip. Acetic acid is not effective on mature Canada thistle.

For Bull thistle, a 5 to 8% solution is useful for killing the first year rosette growth – and this is likely to provide the better long term control. Spraying second year growth late in the season with 8-10% acetic acid effectively kills top growth. However, because Bull thistle grows large and fewer in number than Canada thistle, cutting or clipping may be easier or cheaper.

Follow up, 2003:

In the spring of 2003, following previous year clipping and fall spraying with acetic acid, thistle re-growth was 1-2 weeks later than in unsprayed areas. Thistle density was reduced to no more than 20% of what it had been the previous year. This is an estimate, not based on exact stem counts. A second year of clipping and fall spraying is likely to eliminate thistle growth. Thistles were clipped this year in early July and re-growth will be sprayed.

We saw minimal re-growth in spring 2003 of Bull thistle in a field that was sprayed with 5 to 20% acetic acid in late summer of 2002, and later clipped. We sprayed a few plants in late May 2003 with a 10% solution, representing no more than 20% or so of the population of the previous year. We have seen no re-growth since. There is some concern that Bull thistle may perennate when clipped late in the season of its second growth year (it is normally a biennial), but we have not seen this.

Fall 2003: Noted just a few thistles showing up on areas that received some vinegar in 2002 and summer 2003 – most likely plants that were missed. Obviously, vinegar is an option, but it will take persistence by this or other methods.

Sources:

Most vinegar is about 5% acetic acid, which is marginal for thistle control. There are some pickling vinegars that have up to 7 or 8% acetic acid - which may be adequate. There is a product sold under the label "Ecoclear' which I saw at our local (Truro, NS) Home Hardware, which consists of a solution of, I think, 22.5% acetic acid distilled from natural sources, and there may be other products. The USDA researchers (USDA, 2003) used vinegar.

USDA 2003. Vinegar as a Herbicide Information Page.
http://www.barc.usda.gov/anri/sasl/vinegar.html.

Notes on acetic acid:
Natural vinegar (acetic acid) is produced from the natural oxidation of ethyl alcohol from wine, cider, or other sources, by the action of acetobacter bacteria, otherwise called "mother of vinegar". I have not seen natural vinegars with higher than about 7% acetic acid concentration. Distilling or freeze-drying is used to concentrate it.

Currently, most industrial acetic acid is produced by catalytically combining methanol with carbon monoxide (termed 'the Monsanto process'). I am not sure of the source of typical white vinegar in stores. The organic farming community generally accepts the use of natural source acetic acid, even if concentrated above 7-8%, but rejects that produced by industrial processes.

According to USDA (2003) vinegar is rapidly biodegradable and shows no tendency toward bioaccumulation.

Safety note: Vinegar at over 7% concentration is irritating to the skin. Rubber gloves and boots, and safety goggles, are recommended.