

**The Efficiency of Organic Herbicides Topgun, Ecoclear and Their
Mixture in Controlling Growth and Regrowth of Weed Species
Hogweed (*Heracleum mantegazzianum*), Canada Thistle (*Cirsium
canadensis*) and Horsetail (*Equisetum arvense*)**

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**The Efficiency of Organic Herbicides
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BIOL 448 – DIRECTED STUDIES IN BIOLOGY

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Abstract

The efficiency of the organic herbicide Topgun and Ecoclear was being investigated in this study. The weed species being studied upon were Hogweed (*Heracleum mantegazzianum*), Canada thistle (*Cirsium canadensis*) and Horsetail (*Equisetum arvense*). The purpose of this study was to observe which organic herbicide or their mixture was most effective in controlling these weeds. The continual growth/death and the new growth of the weeds in the treatment sections were being observed and compared. The mixture of both herbicides were most effective at killing the weeds while the Ecoclear herbicide was most effective at controlling new growth of the weeds.

Introduction

When the wrong weed grows in a commercially significant place, economic loss would result. When a hazardous weed grows in a populated place, the inhabitants would be at health risk from it. Hence, efforts were being put into developing methods to keep the undesirable weeds out. When herbicide was first developed, it received wide public and commercial attention for its effectiveness and ease of use (Olson & Eidman, 1992). Nevertheless, farmers prefer herbicides to mechanical weed control mainly because it's more consistent in return than using mechanical weed control (Olson & Eidman, 1992). However, not long till we discovered herbicide's potential long-term detrimental side effect on the environment, quality of the crop and health of exposed people (Olson & Eidman, 1992). Many methods were being developed to reduce the use of herbicides and notably organic herbicides were developed to have the same herbicidal effect but without the side effects from the traditional herbicide.

Topgun and Ecoclear are both non-selective and contact type organic herbicides (Approved Pesticides from Nordical A/S & Ecoclear MSDS). Topgun's main ingredient is Pelargonic acid which is an organic fatty acid that can dissolve the plant cell wall and thus causing desiccation of the plant cell (Approved Pesticides from Nordical A/S). Ecoclear's main

ingredients are acetic acid and citric acid which also cause desiccation of plant cells and thus “burning” the weed leaf. According to both herbicides’ MSDS and manufacture labels, Topgun and Ecoclear will be decomposed by soil bacteria and degraded in soil respectively within a week (Approved Pesticides from Nordical A/S & Ecoclear MSDS).

Both organic acids and their mixture were used on three well-known notorious weeds: hogweed, Canada thistle and horsetail. Hogweed is a tall, invasive, widespread plant that is dangerous for both the local ecosystem and human health (Nielsen, Ravn, Nentwig & Wade, 2005). Since hogweed is a tall broadleaf plant, it is a strong light competitor and has been shown to decrease the species richness of where it invaded (Nielsen, Ravn, Nentwig & Wade, 2005). The watery saps of hogweed contain photosensitizing furocoumarins, a chemical that causes serious burns to the human skin when it touches the skin and reacts with ultraviolet in sunlight (Nielsen, Ravn, Nentwig & Wade, 2005). The injured skin may have long-term light sensitivity as a result as well (Nielsen, Ravn, Nentwig & Wade, 2005). It is originated from Eurasia, but now a growing weed problem in Vancouver and efforts were put into public media to educate and warn the citizens about this hazardous weed (Taguian, 2013). Mechanical weed control is not very effective against this weed since it’s perpetuated by seeds and very hazardous to the workers (Caffrey, 2001). Instead, herbicide treatment combining with mechanical control was shown to be more effective at controlling hogweed (Caffrey, 2001).

Canada thistle is the most common weed in the southern part of Canada and estimated 8.9 million cultivated land were infested with this weed (Hunter & Smith, 1972). The weed adapts better on moist soils with moderate temperature and photoperiod (Hunter & Smith, 1972). Canada thistle regenerates through seed and especially root (Canada thistle and its control, 2008). The root system of Canada thistle is very extensive, can spread laterally to produce clones

of the weed, and is an energy reservoir for the winter and new reproduction (Canada thistle and its control, 2008). Therefore, in controlling this weed, the root system must be the target, though killing off the top-growth can deplete the root reservoir and stop the seed regeneration (Canada thistle and its control, 2008).

Horsetail is another notorious weed in Canada for its negative effect on crop production and toxic effect on livestock. Horsetail adapts better on moister-rich soils such as farm fields, so it could delay the drying and thus harvesting of the crops (Hoyt & Carder, 1962). Horsetail has an extensive rhizome system that is the main route of spread and which can grow rapidly during the summer months (Bond, Davies & Turner, 2007). It is difficult to control horsetail with mechanical methods because the weed can regenerate through the rhizome fragment and tubers (Bond, Davies & Turner, 2007).

In the study described here, the objectives were to assess and overview the herbicidal effects of different organic herbicide concentrations and combinations have on the growth and regrowth of three weed species.

Materials and Methods

Species

- Hogweed (*Heracleum mantegazzianum*)
- Canada Thistle (*Cirsium canadensis*)
- Horsetail (*Equisetum arvense*)

All species are located on UBC Vancouver campus.

Five plots located on UBC campus were isolated and subdivided into treatment and control sections. The Hogweed plot was sprayed twice within two weeks' time whereas the other plots were sprayed only once. The controls were sprayed with soapy water as to mimic the bubbly and shiny film of liquid the herbicide leaves on the weeds. When sprayed topically, the entire shoot system of the plant was sprayed till soaked with the herbicide to ensure complete coverage and effect of the herbicide. When sprayed basally, the herbicide was only sprayed to the base of the stem, about 10cm above ground. Photographs were taking on a biweekly basis

from July to August 2012 to monitor and observe the weeds' growth/dead and regrowth. The treatments were 50% Ecoclear, 50% Topgun, 50% Ecoclear and Topgun mixture; 100% Ecoclear, 100% Topgun and 100% Ecoclear and Topgun mixture. The 50% and 100% mixtures were pre-mixed before spraying to the weeds.

Plot Summary:

Plot 1 (Hogweed, Topical and basal application):

This plot was located in the inner garden of the Biological Sciences Building. Most of the treatment plants were under heavy shading from surrounding trees and only two Hogweed plants were exposed to direct sunlight. The temperature of the overall plot area would be cooler compare to the other plots because of the shading from the surrounding trees and building.

The plot was divided into four sections: control, 100% Ecoclear, 100% Topgun and 100% mixture.

Control	
	100% Ecoclear
100% Topgun	
100% Mixture	

Plot 2 (Canada Thistle, Topical application):

This plot was located on the Sustainability Street at UBC. The plot was beside the sidewalk and within a common weed field. The plot was clear from any building and shading, therefore the weeds were under direct sunlight and the soil would be relatively drier than the other plots.

The plot was divided in to four sections: control, 50% Topgun, 50% mixture and 50% Ecoclear.

50% Topgun	50% Mixture	50% Ecoclear	Control
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Plot 3 (Canada Thistle, Bascal application):

This plot was located at the corner of the McMillian Building. There were many different plant and weedy species in this plot and the Canada Thistles were on the outer edge of the plot. The Canada Thistles in the plot got partial shading from the surrounding plant species which were about the same height as the Canada Thistles.

The plot was divided into four sections: control, 100% Ecoclear, 100% mixture and 100% Topgun.

Control	100% Ecoclear	100% Mixture	100% Topgun
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Plot 4 (Canada Thistle, Topical application):

This plot was located under the bridge connecting the Institute for Computing, Information, and Cognitive Systems Computer Science Building and the Macleod Building. This plot contained mainly Morning Glory and Canada Thistle. Since the plot was between two buildings, it only got partial shadings from the building. Also, the plot was close to the air conditioning unit of the building, so the ambient temperature was warmer and soil was relatively moister.

The plot was divided into two sections, Plot 4A and Plot 4B, and each sections were further divided into four treatment subsections.

Plot 4B

Control	100% Ecoclear	100% Mixture	100% Topgun
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Plot 4A

100% Topgun	100% Mixture	100% Ecoclear	Control
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Plot 5 (Horsetail, Topical application):

This plot was located in the garden between the Irving K. Barber Learning Center and Agricultural Road. The plot contained some weedy species and Horsetail which Horsetail was the majority weed. The plot had partial shading from surrounding tree species.

The plot was divided into two sections, Plot 5A and Plot 5B, and each sections were further divided into four treatment subsections.

Plot 5A

100% Ecoclear	100% Mixture
100% Topgun	Control

Plot 5B

100% Ecoclear	100% Mixture
Control	100% Topgun

Results

Summary Table:

	Plot 1 Hogweed	Plot 2 Canada Thistle	Plot 3 Canada Thistle	Plot 4 Canada Thistle		Plot 5 Horsetail	
				A	B	A	B
June 19	0 hour	0 hour	0 hour	0 hour	0 hour	0 hour	0 hour
June 21	First spray		First spray	First spray	First spray		
June 22	Browning		Browning at base	Browning	Browning		
July 5	Second spray	First spray				First spray	First spray
July 9	Browning progress/ some death		some death and regrowth	Mostly dead	Some death	All dead	Mostly dead, some green stems
July 13		All dead, few regrowth					
July 21	Regrowth observed	More regrowth	Growth observed	Regrowth at top stem + flower	Regrowth (Topgun)	All dead	All dead
July 28	More regrowth	More regrowth	More growth	Regrowth and flowering	Growth (Topgun)	Some regrowth	Some regrowth
Aug. 5	Regrowth and death of control	Growth	Growth and flowering	Growth	Growth	All regrowth	Growth

Table 1: Timeline of events and summary on the plot conditions. (2012)

Plot 1 (Hogweed):

Browning around the edge of the Hogweed leaves was first observed after 48 hours from the spray. The 100% mixture treatment plants showed the most noticeable browning whereas the 100% Ecoclear plants showed considerable less browning on the leaf edge and 100% Topgun treatment plants showed no change of leaf morphology. Four days after the second spray, the 100% Topgun treatment plants were all dead. One of the two plants treated with 100% mixture was dead while the other plant had more browning on the stem and leaf than after the first spray. The 100% Ecoclear treated plants showed more browning on the leaf compared to first spray, but was the least affected in the three treatments after the second spray. Two weeks after the second spray (July 21, 2012), regrowth of the Hogweed was observed in the 100% mixture and 100% Topgun treatment. In particular, the 100% mixture treatment had more regrowth, number and size of new leaf, than the 100% Topgun treatment. On the other hand, one of the two Hogweed treated with 100% Ecoclear was dead, but no regrowth was observed. Overall, the 100% mixture treatment section was observed with most aggressive regrowth, number and size of new leaf, within the three treatments. One of the Hogweed treated with 100% mixture was the biggest and tallest among the treated Hogweeds; on the last observation, the stem and leaves had considerable browning, but the plant was still standing. The 100% Topgun treatment regrowth plants did not show much growth in the last two observations. The 100% Ecoclear treatment section started to have regrowth on the last observation (August 5, 2012). One of the control Hogweeds was dead in the last observation.

Plot 2 (Canada Thistle):

About one week after the spray, all the Canada Thistles were dead and some regrowth in each treatment section was observed. Overall, the growth of the new Canada Thistles in all three

treatment sections were consistent with each other. The 50% mixture and Topgun treated sections had few more regrow Canada Thistles than the 50% Ecoclear treated section.

Plot 3 (Canada Thistle):

After 48 hours from herbicide spray application, browning of the basal leaves and stems was observed. The 100% mixture treatment Canada Thistles showed the most browning, of both leaf and stem at base; moreover, some of the weeds in this treatment were broken at the basal stem and fell. The morphology of the Canada Thistles for the 100% Ecoclear and 100% Topgun treatments was similar-mostly browning and yellowing of basal leaf but not much of the stem. Death of the Canada thistles in the 100% mixture section was observed on July 9, 2012, closed to three weeks' time from the application. Regrowth at the 100% mixture treatment section was observed in two weeks, but none at the other two sections. At the last few observations, the old Canada Thistles in the 100% Ecoclear and 100% Topgun sections did not completely die off as some of them still have green stem. It was, however, hard to determine if there was new growth from the two sections because there were other plants clouding the plot.

Plot 4A (Canada Thistle):

Browning of the Canada Thistle leaves and partial stem was observed 48 hours after herbicide application. The 100% mixture and 100% Ecoclear treated Canada Thistles had more browning leaves than the 100% Topgun treated ones. Three weeks after the herbicide application, the Canada Thistles in the 100% mixture and 100% Ecoclear treatment sections were all dead. At the same time, the Canada Thistles in the 100% Topgun treatment sections still had green stems. Two weeks later (July 21, 2012), the 100% Topgun treated Canada Thistles had continued growth and flowered at the topical stem. New growth of Canada Thistles in the 100% mixture and 100% Ecoclear treated sections was first observed on July 28, 2012, which is three

weeks after herbicide application. The number and size of the new Canada Thistles in these two treatments did not seem to differ much from each other.

Plot 4B (Canada Thistle):

48 hours after the herbicide application, the Canada Thistle in the 100% mixture treatment section was completely dead. The Canada Thistles in the other two treatments still had green stem at that time. About one month after the herbicide application (July 21, 2013), the 100% Ecoclear treated Canada Thistles were observed to be completely dead. While some of the Canada Thistles in the 100% Topgun treatment were dead, new growth was observed on the same observation. At the end of observation period, no noticeable regrowth was observed in the 100% Ecoclear treatment sections, two new small Canada Thistles was observed in the 100% mixture section and many more and larger Canada Thistles was observed in the 100% Topgun section.

Plot 5A (Horsetail):

Death of all the Horsetails in all of the treatments was observed about 4 days after the herbicide application. New growth was not noticed until three weeks after herbicide application (July 28, 2012). More new growth occurred in the 100% Topgun treated section than in the 100% mixture treated section and no new growth was observed in the 100% Ecoclear treated section. On the last observation, all the treatment sections had new growth of Horsetail. The 100% Topgun treated section had the most number of and largest Horsetails and the 100% Ecoclear treated sections had the smallest and least number of Horsetails.

Plot 5B (Horstail):

Four days after the herbicide application, all the Horsetails in the 100% mixture treated sections were all dead. Some of the Horsetails in the 100% Topgun and 100% Ecoclear treated

sections still had green stems or did not seem to get affected by the herbicide. New growth was noticed in the 100% Topgun treated and 100% mixture treated sections about three weeks after the herbicide application (July 28, 2012). The new Horsetails in these two sections were similar in both size and number. No new Horsetail was observed in the 100% Ecoclear treated section. On the last observation, two new small Horsetails closed to the edge with 100% mixture treated section were noticed in the 100% Ecoclear treated section.

Discussion

Hogweed:

The 100% mixture treatment was observed to be the most effective at killing the hogweed since the treated hogweeds were the largest, yet they got browning and died either the same time or faster than the hogweeds received other treatments (Figure 1). However, this treatment was observed least effective at controlling the regrowth of the Hogweed for that the regrowth happened the earliest among all the treatments (Figure 2). Nonetheless, the fast death and regrowth of the 100% mixture treatment could also be affected by the location of the treatment section. The 100% mixture section was located closest to the edge of the garden where the two hogweeds in this section were the largest and received direct strong sunlight whereas the other hogweeds from other treatments were mostly under heavy shading from surrounding trees (Figure 1). Both herbicides were most effective when sprayed in hot sunny days (Approved Pesticides from Nordical A/S & Ecoclear MSDS), which was consistent with the result that the treatment was most effective on hogweeds exposing under the sun the most. Since hogweeds grows better on rich sunlight sites (Nielsen, Ravn, Nentwig & Wade, 2005), the regrowth of the 100% mixture section would be in more favorable condition and harder to control than the other sections. The 100% Ecoclear treatment was observed to be opposite with the 100% mixture:

slowest death of the applied Hogweed and slowest regrowth of the new Hogweed. Again, the heavy shading on this section could play a role in the observed result, but the result was still indicative that the 100% Ecoclear was more effective at controlling regrowth and less effective at killing hogweed than the 100% Topgun for the two treatment sections that have similar environmental conditions and plant morphology. Overall, the 100% mixture treatment was best at killing the existing, well-established hogweeds, and the 100% Ecoclear was most effective at controlling regrowth.



Figure 1: Hogweed, top to bottom: 100% mixture, 100% Topgun, 100% Ecoclear. Left: June 22, 2012. Right: July 9, 2012. Both the mixture and Topgun treated hogweeds had died on July 9, but Ecoclear treated hogweeds only showed browning.



Figure 2: Hogweeds. Left to right: 100% mixture, 100% Topgun and 100% Ecoclear. Both 100% mixture and Topgun treated sections had new hogweeds grown out. There were more and larger new hogweeds in mixture section than the Topgun section. No new hogweed observed in Ecoclear treated section yet.

Canada thistle:

On the four plots with Canada thistle (2, 3, 4A and 4B), mixture treatment was most effective at killing the existing Canada thistles and Ecoclear treatment was most effective at controlling the regrowth of the Canada thistles. In all of the treatment plots, the mixture treatment was either having the same killing speed with others or the fastest. Likewise, the Ecoclear treatment was either having similar regrowth status as the other treatments or having no regrowth at all.

In plot 2 where all the herbicide treatment concentrations were halved, all of the treatment exhibited the same killing rate. Also the killing speed was faster than the other 100% treatment plots, one week's time verses close to three weeks' time. This suggested halving the concentrations did not seem to affect the herbicidal effect of the herbicides much. However, environmental factor could play a role in this observation as well. Plot 2 was located in a clear weed field with direct exposure to sunlight whereas the other two plots all have some shading from the surroundings (Figure 3). According to the herbicides descriptions, they were most

effective when apply in hot sunny days (Approved Pesticides from Nordical A/S & Ecoclear MSDS). Therefore, the condition in plot 2 would be more favorable for the herbicides to be more effective than the other plots.

In plot 3, the Canada thistles received a basal treatment and the mixture treatment was most effective at killing the weed but least effective at controlling the regrowth. The other two treatments performed similarly to each other at controlling the growth and regrowth of the weed. The result suggested the two herbicides could have doubling effects on the weed, especially used basally. The clouding from the other surrounding plants could also be a factor in controlling the regrowth of the Canada thistles. In Casper and Jackson's study (1997), they suggested plants experienced underground competitions. In the mixture treatment section, there were lesser of other plants occupying in or around the section compared to the other two sections. Since the root of Canada thistle was the nutrient reservoir for the new top-growth, having more surrounding plants might be more competitive for the thistle for underground resources which contributing to the lesser regrowth in the Ecoclear and Topgun treatment sections.

In plot 4A and plot 4B, in general, the herbicides were less effective on the thistle compared to the other plots. In particular, the Topgun treatment was least effective in both plots with continual growth of the thistle, flowering at apical stem, and fast regrowth (Figure 4). Furthermore, the flowering of the Topgun sections in 4A was around the same time as in the control section. This might be an indication that there might be other limiting factors such as environmental factors on the herbicides and in which Topgun herbicide got affected the most. In Hunter and Smith's study (1972), they found that temperature and light quantity were factors that can change the susceptibility of thistles to herbicides and as a result, the rate of death and the quantity of herbicides needed for 100% kill were affected.



Figure 3: Canada thistle. Left to right: plot 2, plot 3, plot 4A.



Figure 4: Canada thistle. July 21, 2012. New growth and flowering at the apical stem.

Horsetail

The 100% mixture treatment was the most effective for killing the horsetail in both 5A and 5B plots. The 100% Ecoclear treatment was the most effective for controlling the new growth of horsetail. In plot 5B, the new growth for both 100% Topgun and 100% mixture sections was about the same; however, since there were less horsetails present in the 100% Topgun section than the 100% mixture section even before the herbicide application, the ratio of horsetail regrowth was higher for the 100% Topgun treatment (Figure 5).



Figure 5: Horsetail. July 21, 2012. Left: 100% mixture section, right: 100% Topgun section.

In conclusion, the mixture of Topgun and Ecoclear was most effective at killing the three different weeds which suggested the two herbicides could have additive effect on the weeds. Also, Ecoclear was most effective at controlling the regrowth of the weeds which suggested Topgun was not effective at controlling the new growths and it could lessen the Ecoclear's effect on new growth when mixed in.

Future Studies

When spraying the weeds with the herbicides, the quantity of the herbicides used on each plant/section was not measured. There could be a difference in the result as different amounts of herbicide used on the weeds; nevertheless, all the weeds were sprayed till soaked to ensure the herbicides could take effect. In Hall, Swanton and Anderson's study (1992), they showed that herbicides used at different stages of weed growth could have different controlling effect on the weeds. So for future studies, one could monitor the effect of herbicides on different growth stages of the weeds, especially younger stages as the herbicides instructions indicate the herbicides are more effective on young weeds (Approved Pesticides from Nordical A/S & Ecoclear MSDS).

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