Pesticide Alternatives 2024: A Summary

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The All-Ireland Pollinator Plan is a framework bringing together different sectors across the island of Ireland to create a landscape where pollinators can survive and thrive. Its implementation is coordinated by the National Biodiversity Data Centre.

www.pollinators.ie

Introduction

Pesticides are potent chemical cocktails that can kill, harm and disorientate pollinators. The All-Ireland Pollinator Plan encourages everyone to eliminate pesticides for the benefit of pollinators and biodiversity more widely. Plants that are considered 'weeds', such as Dandelions, are often hugely valuable for biodiversity. We should learn to celebrate these native wildflowers, not remove them.

However, sometimes plants need to be removed for health and safety or other reasons. For decades, synthetic herbicides like glyphosate have been used to kill unwanted plants, but many studies have shown their harmful impact on environmental and human health.

In recent years, individuals, groups, organisations and public bodies have tried to move away from harmful herbicides and use alternative methods for removing plants.

About the survey

Peer-reviewed research into pesticide alternatives is ongoing, but the move away from pesticides is happening now, and the need to eliminate harmful chemicals is urgent.

In 2024, the All-Ireland Pollinator Plan released a survey 'Pesticide alternatives'. It was sent to a range of supporters and partners to the Pollinator Plan and was also made available to the general public. The survey received 82 anonymized responses and was completed by a range of different groups and individuals across the island of Ireland, including local authorities, community groups, Tidy Towns, group water schemes, landscape contractors and individuals.

The aim of the survey was to gather information on pesticide alternatives currently being used on the island of Ireland, how effective they are, and the challenges of using them.

The survey focused on five common pesticide alternatives: hot foam, steam weed control, weed burning, manual control, and organic sprays. For each method, participants were asked:

- *On a scale of 1-10 how successful have you found this method?*
- *What challenges have you found with this method?*
- *What tips or advice would you give to others considering this method?*
- *How do you plan to use this method in the future?*

For manual control, participants were also asked: *What type of manual control do you use?* and for organic sprays: *What sprays have you tried (include brand name if known)?*

The results of this survey do not constitute recommendations by the All-Ireland Pollinator Plan, which must be evidence-based and backed up by science. Rather, the intention of this summary is to share the learnings of the survey and the lived experiences of pesticide alternatives on the island of Ireland to help people make more informed decisions when choosing alternatives to pesticides.

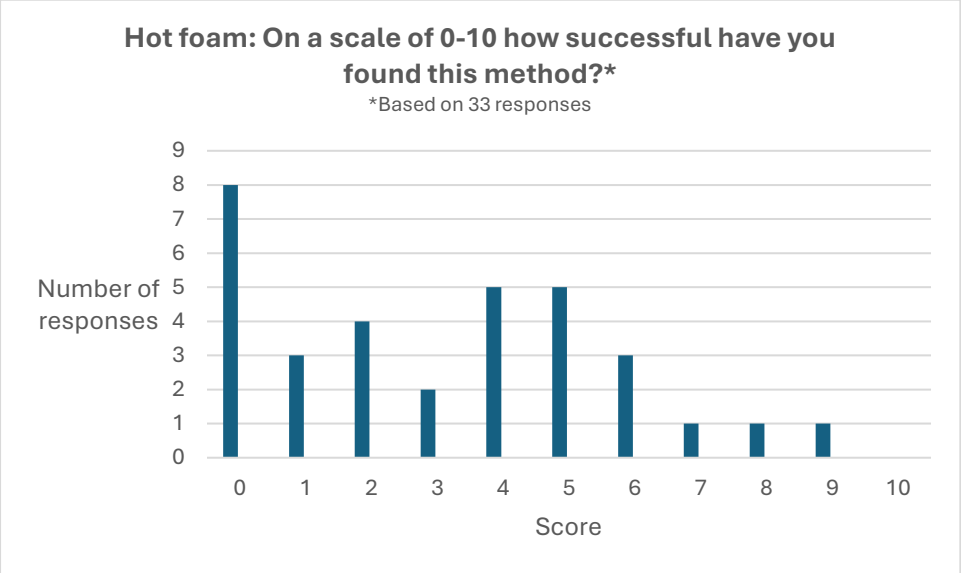
Dr Úna FitzPatrick & Kate Chandler,
All-Ireland Pollinator Plan

Hot foam

What is hot foam?

Hot foam works by trapping hot water under a layer of foam, extending the time unwanted plants are exposed to high temperatures. It is applied to target plants using specialized equipment.

Average score: 3.2/10 (based on **33** responses)



Results

Participants had varied experiences with hot foam. The open text responses are summarized below.

What challenges have you found with this method?

- **Health and safety concerns:** Parts of the hot foam equipment were reported to get very hot. Closing paths to carry out work could lead to trip hazards. One participant through there was potential for water and soil pollution.
- **Demands on resources:** This was a common difficulty. Some said there were not enough staff available to use hot foam effectively, so specialist contractors and equipment were required. There was general agreement that sufficient resources are essential to ensure the correct application of hot foam, otherwise it will not be effective.
- **Effectiveness/ regrowth of plant matter:** A common complaint was not all target plants were killed, or plants grew back. Some found hot foam more effective on less established plants, moss and algae. There were comments that it struggled to kill roots.
- **Access, practicalities of equipment:** Due to the equipment required to use hot foam, access was considered difficult in some areas. Some reported the method is noisy and can be slow.
- **Cost:** This was a recurring challenge, with several participants citing the cost of using hot foam or hiring specialist contractors and equipment.
- **Use of water and energy:** Some participants reported a high volume of water and energy consumption in using this method.

What tips or advice would you give to others considering this method?

- **Think about cost and resources:** Think carefully about your budget and tools at your disposal. You will need sufficient resources to operate the machine correctly and carry out repeated application of hot foam.
- **Think about where you want to use it:** One of the challenges of hot foam is limited accessibility in certain areas due to the equipment required. Playgrounds and urban settings were suggested as potentially suitable locations for hot foam.
- **Consider health and safety:** Potential for mess and high temperature of foam means health and safety considerations are important.
- **Test it first:** It was advised to test the method before committing to it, either by renting a machine or getting demonstrations on various types of machines to assess suitability.

How do you plan to use hot foam in the future?

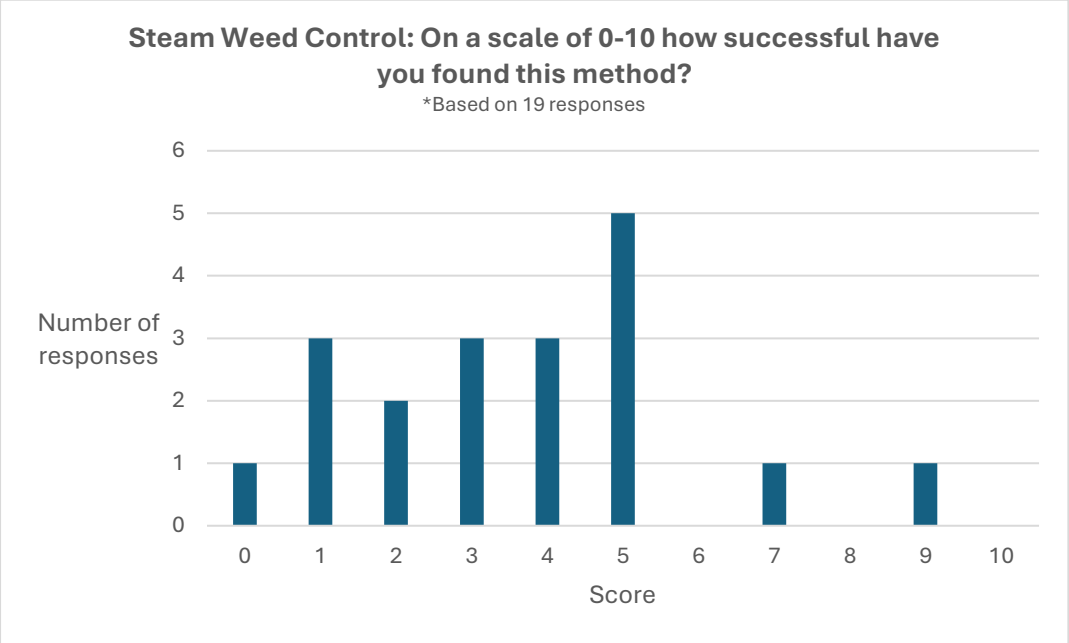
- 36% of those who used hot foam said they would use it again in the future.
- **In certain areas:** 7 out of 33 respondents said they would be using hot foam instead of herbicides in certain areas, e.g. large campuses, urban public squares and streets, horticultural beds, small spot areas, and paths in parkland where access is available.
- **At certain times:** 2 respondents said they would use hot foam at certain times, either certain times of year or when weeds are small. One of these participants said they would repeat application three times a year between February and September.
- **Alongside other pesticide alternatives.** 2 respondents stated they would continue to use hot foam as part of ongoing experimentation with other pesticide alternatives.
- **We will not be using it in the future.** 6 respondents stated they would not be using hot foam in the future.

Steam Weed Control

What is steam weed control?

Steam weed control works by applying hot water to unwanted plants. It is applied using specialized equipment.

Average score: 3.6/10 (based on **19** responses)



Results

Participants had varied experiences with steam weed control. The open text responses are summarized below. Despite the higher average score, one or two participants stated in open text responses that they found hot foam more effective than steam weed control.

What challenges have you found with this method?

- **Effectiveness/ regrowth of plant matter:** This was the most commonly reported challenge by survey participants. Some participants reported regrowth of plant matter after a short period of time, particularly deep-rooted plants or established weeds. One participant reported that steam weed control “melts the leaves, doesn't damage the roots. Leaves don't dry properly so the withered uppers can't be cleaned away.”
- **Health & safety concerns:** Two participants reported health and safety concerns in public spaces, though they did not elaborate on the nature of these concerns.
- **Demands on resources:** Time, tools, and specialist equipment/contractors were mentioned as a challenge by a couple of participants. One participant said: “contractors are expensive and unavailable outside of Dublin.”
- **Access/ practicalities of equipment:** As with hot foam, this was a common complaint due to the need for a vehicle, size of equipment, and maneuverability.
- **Cost:** Two participants mentioned cost as a challenge with this method.

What tips or advice would you give to others considering this method?

- **Think about cost and resources:** Research different methods and assess the resources available to you, e.g. funds, staff, training, vehicles available to tow the machine. You may need a professional operator and equipment. Application can be time-consuming. Appropriate health and safety PPE will also be required.
- **Training:** Proper training is essential for the staff who will be tasked with using this method.
- **Think about where you want to use it:** Due to the size and maneuverability of the equipment, participants said it is important to think carefully about where you need to use this method. One participant said steam weed control is great for kerbs. Another recommended using it in areas you can close to the public, other it is difficult to manage health and safety.

How do you plan to use steam weed control in the future?

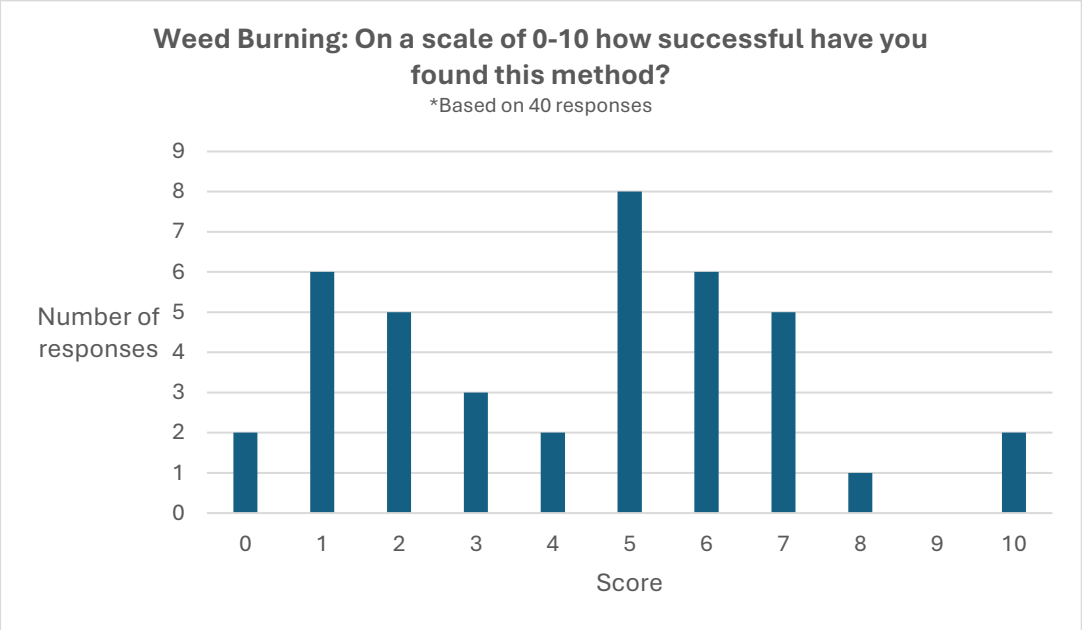
- **Will use in certain locations:** 5 of 19 respondents said they would use steam weed control in certain locations in the future, including council sites as part of the council's pesticide reduction programme, and annually on a large campus area. Five participants definitively said they would use steam weed control in the future.
- **Will not use:** Despite steam weed control scoring higher on average than hot foam, 58% of participants said they would not use it in the future. Reasons given include the ineffectiveness of the method and inadequate equipment. One participant was unsure how steam weed control would be used in the future, due to availability.

Weed Burning

What is weed burning?

Weed burning involves killing unwanted plants using a flame. It requires specialized equipment.

Average score: 4.3/10 (based on **40** responses)



Results

Participants had varied experiences with weed burning. The open text responses are summarized below. Despite scoring higher on average than some methods, several participants struggled with this method.

What challenges have you found with this method?

- **Health & Safety:** This was a common challenge for weed burning. The main cause for concern was the gas, naked flame, and potential fire risk. This method was considered particularly dangerous in hot/dry weather, when vegetation is dry. To mitigate fire risk, hard surfaces must be cleaned of debris, and weather conditions must be right.
- **Cost:** Several participants mentioned cost as a challenge with using this method. Specific issues include labour costs and cost of fuel.
- **Effectiveness/ regrowth of plant matter:** Though some found this method effective in the first instance, there were several reports of plant matter regrowing. Here are some quotes from survey participants:
    - *"You have to stand over the weed until it fully burns or it won't work. Even so the roots still survive."*
    - *"The burning of the plant is effective however it needs a number of 'hits' to truly effect [sic] the growth rate of the plant as the roots are generally unaffected. Over time the plant is weakened."*
    - *"Have to burn when weed is in initial growth stage or you have to keep coming back with heat method. Plus each weed takes 30 seconds plus to wilt or burn."*

- **Not suitable for certain areas:** It is not suitable for limestone areas as it cracks and fragments fly from it. Others said it is only suitable for hard surfaces and therefore doesn't provide a full weed control solution for a landscape. Others said it is awkward to use on cobblestones. It requires getting an electrical current to the site, which may also be a challenge. One participant reported this method left scorch marks on kerbing.
- **Inefficient/ demands on resources:** Several participants reported the application of this method is slow, depends on dry, calm weather and small weeds – taller plants may need to be cut back with a strimmer first. Some reported it is not selective. There were some complaints about the equipment required to use certain versions of this method, and that it was cumbersome to carry. Some said it was difficult to find the right equipment, e.g. the correct gas bottle, and training staff in using this method was time-consuming. Here are some quotes from participants:

    - *"Trialled driven machine that used gas burner and heated metal roller to heat the vegetation - very slow and ran out of gas! Cylinder type not used in Ireland and trial ended!"*
    - *"The kerosene powered version can be temperamental to start and service. It requires a regimented regime of use over several years to reduce and eliminate the seed bank on surfaces."*

What tips or advice would you give to others considering this method?

- **Regular application:** Consistent and regular application of this method was considered essential for it to be effective, due to the regrowth of plant matter. One participant recommend a 'little and often' approach.
- **Health & Safety:** Due to the nature of weed burning, health and safety was considered a key consideration, particularly in the summer when fire risk is higher. Recommendations include having a water source close by in case of fire spread, wearing security shoes, avoiding weed burning in windy weather, and keeping children clear.
- **Time it carefully:** Careful timing was considered a key recommendation, for maximum effectiveness of this method. A couple of participants recommended burning on a dry day (though it should be noted this may increase fire risk, and steps should be taken to mitigate this risk). Others suggested burning weeds early in their lifecycle, when they are not too big.
- **Choose location carefully:** Weed burning was not considered suitable for all locations and surfaces. Small areas, tarmac and concrete were considered better suited to this method.
- **Invest in correct resources/training:** Some participants recommended using a professional operator. One participant was exploring different types of equipment to allow them to trial on larger sites. Staff training was considered essential. Here is a quote from one participant:
    - *"Buy the best weed burner you can afford. Quickcrop do a really powerful on which you can see on their website."*

How do you plan to use weed burning in the future?

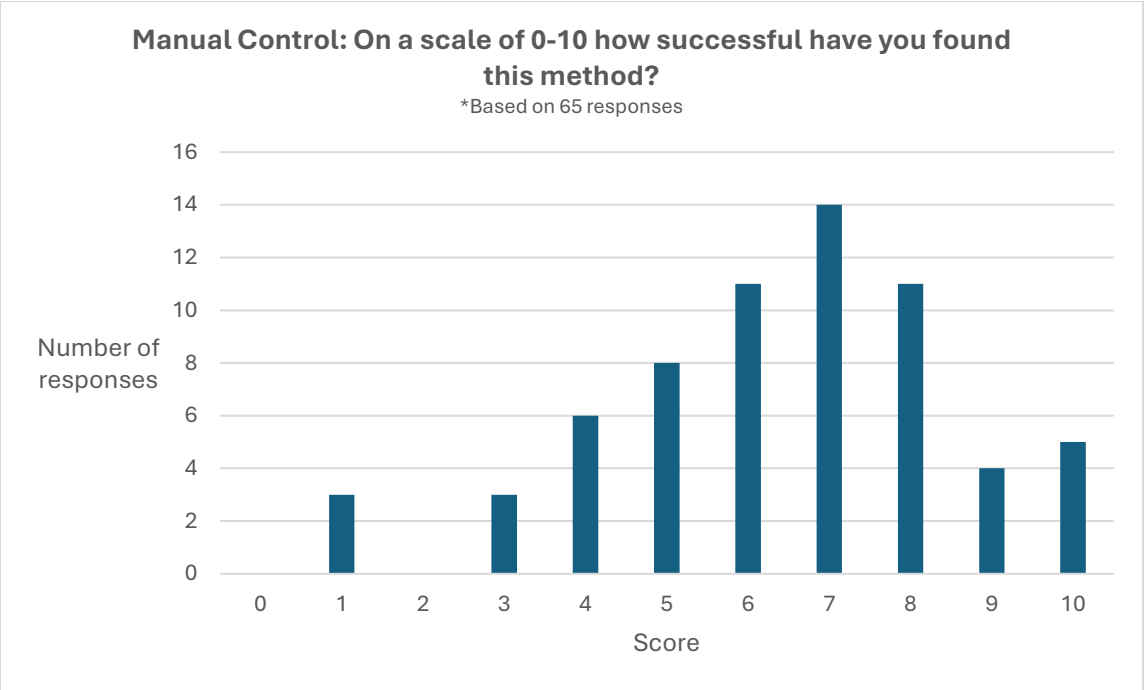
- **Will not be using in the future:** Despite this method gaining a higher average score than some other methods, 40% of respondents stated they would not be using weed burning in the future. Some of the reasons given include health and safety issues, potential environmental impact of fuel, and ineffectiveness of method.
- **In specific areas:** 12 of the 40 respondents said they would continue to use weed burning in specific areas such as hard surfaces, paths, patios, gravel, and spot treatments.

Manual Control

What is manual control?

Manual control is when unwanted plants are removed by force, e.g. by hand, using tools such as hoes, trowels or brushes, or mechanized brushes on specialized machines.

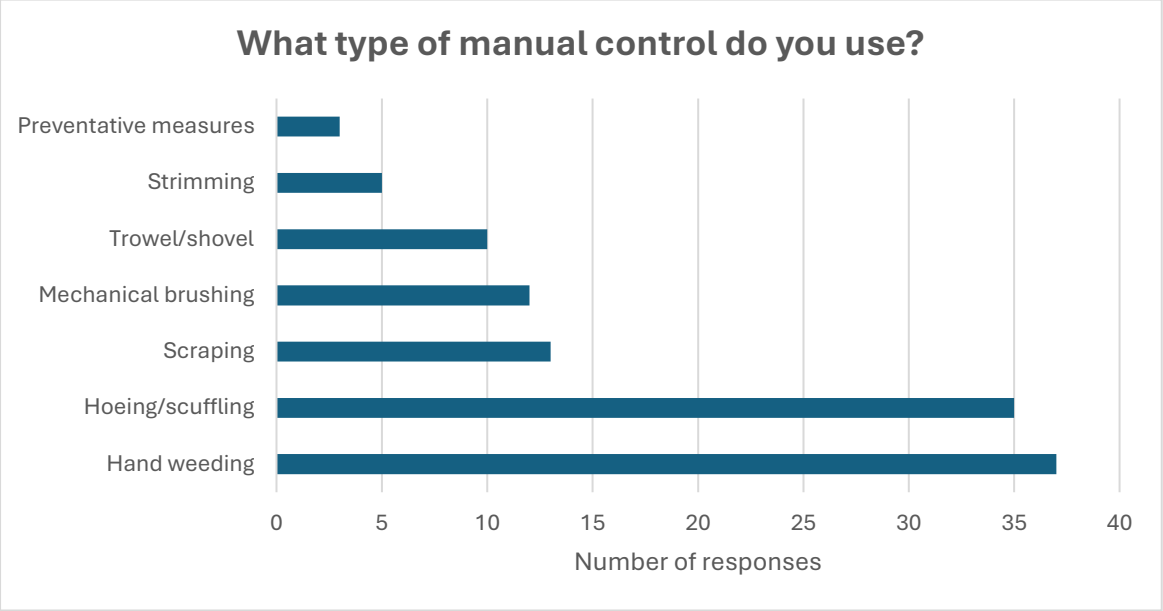
Average score: 6.4/10 (based on **65** responses)



Results

Participants generally had success with manual control. Despite the challenges cited, many stated they found manual control effective. Because of the varied nature of different manual control methods, an additional question was added to this section of the survey to ascertain what type of manual control participants used.

What type of manual control do you use?



Hand weeding: Hand weeding was by far the most common method of manual control. Many respondents used this in conjunction with other methods. For example, staff hand weed bedding areas but not on a larger scale as this was considered too labour intensive.

Hoeing/scuffling: This was the next most popular method of manual removal. Some participants said they used this method in beds rather than on hard surfaces, and many used it in conjunction with other methods. Specific types of hoe mentioned include the 'swiss hoe' and 'oscillating hoe'.

Scraping: Some participants scraped weeds away, for example with the blade of a shovel. Three participants said they used this method on hard surfaces, such as kerbs and driveways.

Trowel/shovel: A variation on hoeing and scraping, some used trowels, shovels, or other hand tools to remove unwanted plants.

Mechanical brushing: The use of mechanical wire brushes is popular where larger areas of land need to be managed, e.g. public land managed by local authorities. This often involves the use of push-along or ride-on machines.

Strimming: Some participants used motorized strimmers to remove or shorten unwanted plants.

Preventative measures: Three respondents mentioned preventative measures they used to stop unwanted plants from growing. These included mulching, using coverings such as stone and weed-control membranes like mypex, cardboard and woodchips.

What challenges have you found with this method?

Labour intensive and physically demanding: Another common complaint, the labour intensive nature of many manual control methods can be an obstacle. This is particularly the case where large areas of land need to be managed, e.g. public land managed by councils, or community spaces looked after by groups like Tidy Towns. Short staffing and lack of volunteer availability were cited as specific issues in relation to this challenge. In the case of specialized equipment, e.g. wire brush machines such as 'Weedhex', the method requires staff to be trained to use it properly, as well as supervise pedestrians and traffic in public spaces, and pick up debris after machine. Many people also reported that manual control is physically demanding.

Regrowth: Regrowth of plant matter was the second most common challenge after labour intensity. Some reported it was difficult to remove deep roots, and weeds grew back fast. Weather can be an obstacle in repeating this method.

Time consuming: There were many reports that manual control is time consuming. This is due to the slow nature of the task, and the necessity of repeating the method throughout the growing season.

Cost: Cost was another challenge. This could be in relation to staff costs and labour hours, or the purchasing, running and maintenance of equipment e.g. Weedhex machines.

Ineffective on certain surfaces: Manual control was considered difficult on some surfaces, e.g. brick. The design of hard landscaping surfaces was cited as an issue. Whilst some found manual control effective on pavements, road edges, walls and kerbs, others found it ineffective on hard surfaces, grasses, cracked pavements and block paving. Some methods like strimmers were considered unsuitable on gravel surfaces due to flying debris. Smaller areas were considered more suitable for manual control than larger ones.

Public perception: One participant said a challenge of manual control was unrealistic expectation, and a lack of understanding of natural environments.

What tips or advice would you give to others considering this method?

Participants were keen to encourage anyone considering this method to 'go for it'. Many considered this method the most environmentally friendly pesticide alternative. Others experienced benefits to physical and mental health. Some participants considered certain types of manual control particularly effective, such as hoeing and mechanical brushing.

Time it well: 'Early and often' was the main message from respondents. It was considered important to carry out manual weeding early in the season and repeat regularly throughout. Others said best results are achieved when manual weeding is done on a dry day.

Preventative measures: Several respondents stressed the importance of preventing weed growth in the first place. Some landscape and streetscape features were considered responsible for weed build up, such as poor pointing in joints in paving. Mulching was a popular preventative measure in beds, and planting beds fully to minimise growth of unwanted plants.

Ensure costs/resources are in place: Many participants pointed out the importance of securing budget and resources to use this method, such as staffing. One recommended a street sweeper as the most effective method.

Use in conjunction with other methods: A couple of respondents recommended using manual control as part of a wider strategy, with one saying that this method is most effective "once weeds have been brought under control using one of the other methods, such as burning."

Raise public awareness: Public awareness and community engagement was considered key to the success of this method. One participant recommended running 'scuffle evenings', inviting businesses and community groups to take part.

Use in certain locations: A couple of participants considered certain environments better for this method than others, such as beds and containers, and mechanical removal via a weeding machine on large areas of brick.

How do you plan to use manual control in the future?

55% of respondents who used this method said they would use manual control again in some way.

In certain areas: 14 of the 65 respondents said they would continue to use manual control in the future in certain areas, e.g. high-maintenance spaces, small urban parks, public parks, vegetable gardens, around verges or at the base of trees, on concrete paths, in planters, on driveways, or where other techniques are considered inappropriate.

Continue or increase manual control: 11 participants said they would continue to use manual control, with two respondents saying they planned to increase their use of this method. One participant said they would continue to use manual control but would need plenty of people to do it.

At certain times: Three respondents said they would use manual weed control at certain times, e.g. early spring, and would continue to use this method frequently throughout the season.

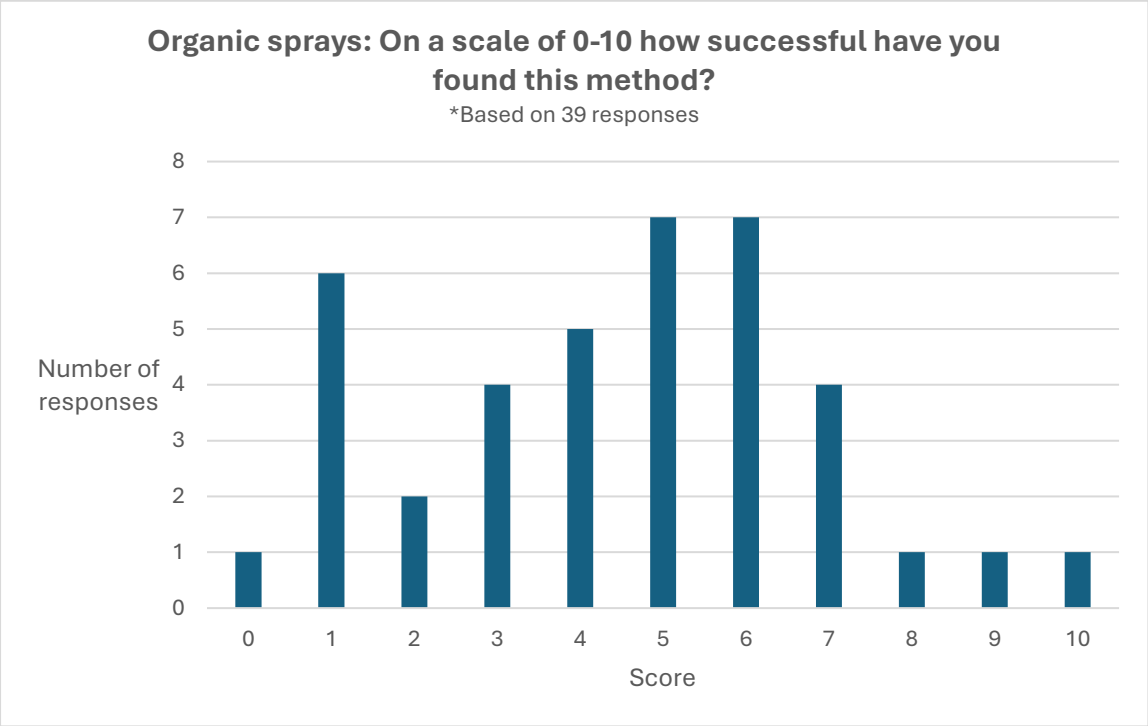
In conjunction with other methods: Seven respondents said they would continue to use manual control alongside other methods, such as preventative measures (creating planting schemes that reduce need for 'weed control'), mulching, weed burning, and hot foam.

Organic sprays

What are organic sprays?

Organic sprays are liquid alternatives to traditional pesticide sprays. Their ingredients are natural or organic and are less harmful to the environment than traditional pesticides such as glyphosate. Organic sprays are available to purchase but can also be homemade.

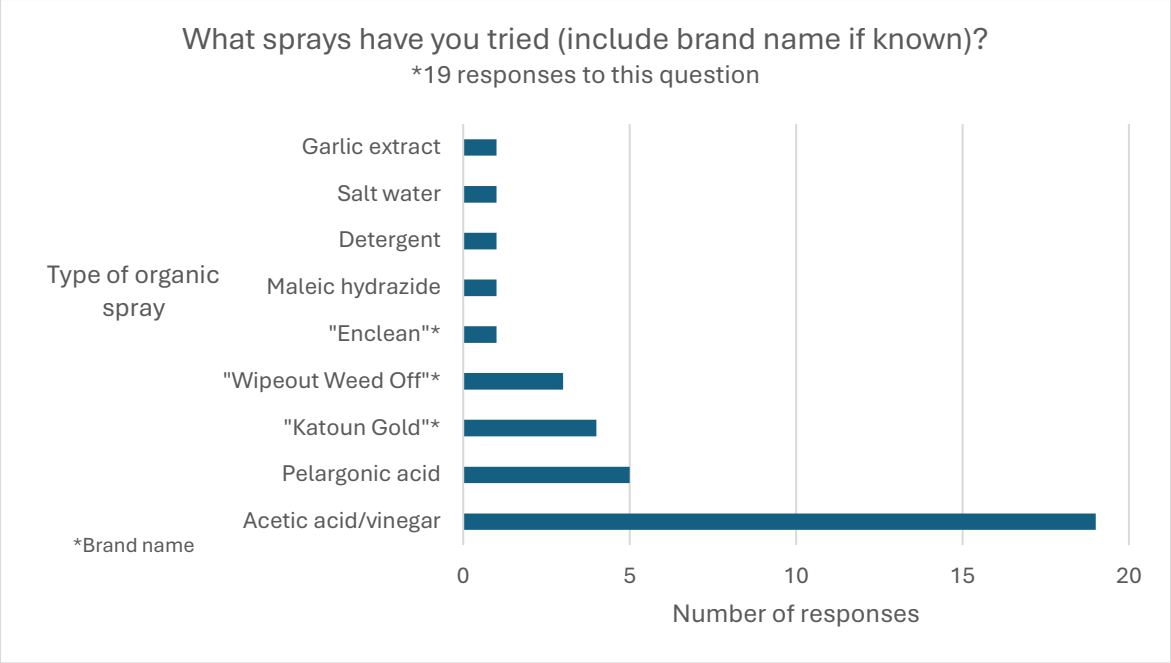
Average score: 4.5/10 (based on **39** responses)



Results

Results were mixed with this method. Some had great success and others less so. The type of sprays used varied greatly. Because of this, an additional question was added to ascertain what type of organic spray participants used.

Note: The All-Ireland Pollinator Plan does not endorse any of the brands or methods mentioned below. Any treatment which is harmful to wildlife should be avoided.



Acetic acid/vinegar: Acetic acid is an organic compound found in vinegar and many branded organic sprays. Vinegar was also sometimes used in a mix with other substances, e.g. salt or epsom salts (magnesium sulphate).

'Enclean': A branded spray containing nonanoic acid (also known as pelargonic acid).

Detergent: One participant used an 'eco detergent'. Further details were not given.

Garlic extract: One participant used garlic extract as a homemade organic spray.

'Katoun Gold': A branded spray containing pelargonic acid.

Pelargonic acid: An organic compound also known as nonanoic acid, found in many branded sprays.

Salt water: One participant used a 'brine mixture', though further details were not given.

'Wipeout Weed Off': A branded spray with acetic acid as the main ingredient.

What challenges have you found with this method?

Regrowth: Regrowth was the most reported problem with organic sprays. Of those who reported this problem, 12 respondents used acetic acid or organic sprays containing acetic acid (such as branded products and vinegar); five used pelargonic acid or branded sprays containing pelargonic acid; and three used salt or salt mixtures.

Correct strength/volume: Three respondents said it was necessary to use high volumes for effective treatment of unwanted plants, or applying the correct strength. Two participants reported this issue with vinegar mixes. One reported this challenge with pelargonic acid.

Harmful to humans/biodiversity: One participant reported their homemade acetic acid solution could be harmful on skin and when inhaled. A few respondents reported concerns around potential harmful effects of acetic acid sprays and vinegar to pollinators, biodiversity, soil, and water.

Cost/resources: Many participants found cost a challenge with organic sprays. Specific examples include costliness of branded sprays compared to traditional herbicides. Other costs and resource demands may include staff training, PPE, keeping records of the spray's use, appropriate storage and disposal. Time commitment was another challenge as some methods can be time-consuming. One participant said it was hard to source white vinegar in bulk for their homemade spray.

Timing/ weather conditions required: Correct timing and weather conditions were considered a challenge with organic sprays. Some brands require dry conditions at the right temperature.

Doesn't treat some weeds/ineffective: Some respondents found organic sprays ineffective, or ineffective on certain plants (e.g. one participant found Wipeout Weed Off ineffective on docks).

What tips or advice would you give to others considering this method?

Repeated application: Several participants using sprays containing pelargonic or acetic acid said repeated application was necessary for best effect.

Apply at right time/in right conditions: Several participants using sprays containing pelargonic or acetic acid said timing was important for best effect, e.g. applying when weeds are young, early in the morning, and during dry weather.

Use in conjunction with other methods: One respondent who used 'Wipeout Weed Off' recommended using manual control ("hand scraping, wire brushing/sweeping") after using the organic spray.

Use in certain areas: Respondents who used acetic acid-based sprays recommended using it on small areas, annual weeds, paths and roadsides, liverworts and mosses in paved areas.

Training and resources: One respondent recommended staff training before using this method.

How do you plan to use organic sprays in the future?

Continue to use/sometimes/in certain areas or situations: 14 of the 39 participants (36%) said they would continue to use organic sprays, would use them sometimes, or would use them in certain areas such as smaller hard surface areas. One respondent said organic sprays have helped them transition away from glyphosate, and they will gradually move away from this to manual removal.

Need to do further research: Two respondents said they would be trying out different sprays and waiting the results of ongoing research into pesticide alternatives.

In conjunction with other methods: One participant said they would continue to use organic sprays in conjunction with other methods, though the exact techniques weren't specified. Another respondent said organic sprays had helped them transition away from glyphosate.

Will not be using: Six participants said they would not use organic sprays in the future.

Have you tried any other pesticide alternatives?

All respondents were asked to list other pesticide alternatives they have tried which had not already been mentioned in the survey. There were a variety of answers.

Note: The All-Ireland Pollinator Plan does not endorse any of the methods mentioned below. All our official recommendations must be evidence-based and supported by science.

Mulching
The most common response was mulching, which some participants mentioned in the 'manual control' section of the survey under 'preventative measures'. However, further detail was given in this section which may be useful. Here are some quotes with details on mulching:

- *"Ground cover with newspaper and mulch, not bad for one season if newspaper is a few sheets thick."*
- *"I approach it with mulch, mulch and more mulch. I sheet mulch in some situations (tree planting/orchards/fruit). I do mulching around ornamental areas and I underplant as much as possible. I also clip and drop the clippings in some situations."*
- *"For weeds over a large area, thick cardboard and mulch on top of that."*

Suppressing weeds: Suppressing or smothering weeds was another preventative pesticide alternative. Participants covered the chosen area with old carpet or covers, plastic sheets or mypex.

Planting to attract beneficial insects: Some participants stated they grew plants to attract beneficial insects and predators like ladybirds and hoverflies.

Home recipes: Different homemade solutions were suggested. These include a diluted salt mix on patio weeds, chilli powder to repel vermin, coffee grounds, eggshells, boiling water, pure alcohol, sheep wool, fireplace ash and dried lavender stems to repel slugs.

- *"Have tried diluted salt from a recycled squirty bottle. This is relatively cheap, and easy. Is OK for on weeds growing on between the patio slabs but not where there would be any other plants of interest growing."*

Solarization: One respondent used solarization, a method where plastic sheets are put over a bed to heat the soil and kill vegetation beneath.

Desiccation: One respondent in a local authority is working with the University of Galway on a desiccation method for knotweed rhizomes.

Let it grow: It was encouraging to see some respondents choosing to let weeds grow, taking a 'non-intervention' or low-intervention approach.

- *"We are one of the larger group water schemes in the country and until we got involved in a source protection pilot project would have used "Round up" at all our meter locations (1800 approx.) Twice a year now we "Let it Grow" and have installed tall white posts at meter locations so they can be readily identified."*

Any other comments or advice?

Finally, all survey participants were asked if they had any other comments or advice on pesticide alternatives. Some reiterated earlier advice such as removing weeds early. Others said that a move away from pesticides is already happening, which is encouraging to see. Some themes were recurring, such as:

We need to change our attitudes to 'weeds'
Throughout the survey, some participants pointed out that a cultural change is needed in how we view 'weeds'. Resistance to change was a common obstacle and was observed in those responsible for applying pesticides (such as staff and volunteers) and in the wider community where public perception has at times led to backlash against pesticide alternatives or the 'let it grow' approach.

- *"Behavioural change is big challenge within the organisation and the cheap, quick and easy option is always preferred over the environmental benefits by some people unfortunately."*

- *"When spray locations were reduced in the town there was significant backlash from public groups in housing estates and unfortunately the Tidy Towns. This backlash included anonymous written threats."*

- *"When I deal with queries about weeds from public I am in a strong position from the start as people know that we don't use pesticides and generally appreciate this stance. It makes the decision easy - our starting position is No Spray and we take it from there. It might mean asking people to tolerate unkempt areas and usually people understand the benefits of this to society when you explain the situation. So we are having conversations regularly with the public and getting the message out there that pollinators are important."*

- *"[We need] to see a greater campaign against the use of roundup for domestic use. Here in the West of Ireland, people use this stuff to keep down the weeds around their houses and even can be witnessed spraying on roadside verges."*

Prevention rather than cure
Several participants said preventing unwanted plants was key, e.g. by 'designing out the problem' and encouraging healthy soil development.

- *"Fill all joints in paving […] when considering hard surfaces keep weed growth and drainage in mind."*

- *"Reduce monocropping on farms, allow wild areas in gardens, take care of the soil. A healthy soil will produce plants that resist pests which reduces the need for pesticides."*

Consider the trade-offs
Some trade-offs of moving to pesticide alternatives were mentioned. These included potential increased costs, such as labour costs, carbon and water.

More information needed
Several respondents wanted more information on pesticide alternatives and their potential impacts on the environment.

Any other comments or advice?

Report compiled by Kate Chandler, Communities and Engagement Pollinator Officer, National Biodiversity Officer.

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