1 Introduction

3 Current Methods of Weed Management

because it is not biodegradable and prevents rain from penetrating the soil. Matting should be held down firmly to stop it moving in flooding or high winds. This can be achieved with mulch, rocks, or wooden, wire or plastic pegs.

Figure 1 Newspaper ground cover (Sustainable Landscape Roundtable, 2006)

Figure 2 Mulch over top of newspaper ground cover (Sustainable Landscape Roundtable, 2006)

Figure 3 Cardboard ground cover(Braden, 2012)

Advantages:

- Can provide long-term weed control
- Helps retain moisture depending on material used
- Reduces erosion
- Reduces compaction
- Helps maintain even soil temperature
- Aesthetically pleasing

Disadvantages:

- Weeds will penetrate if too thin
- Can be blown away
- Can be disturbed by animals
- Can be washed away by rain or floods
- Time consuming to install
- Delayed increase of soil temperature during spring
- Weeds will come up in any gaps left around plants
- Fate of plastic in the environment is unknown
- Fate and effect of ink from newspaper unknown

3.2 Soil Solarisation

Soil solarisation is a non-pesticidal method of controlling weeds and pest plants that is suitable for killing weed seeds and seedlings. By placing UV resistant plastic sheets on top of the soil during summer, it allows the suns heat to be trapped in the soil raising the soil temperature to a level that will kill most weed seeds and seedlings. Ideally the soil should be covered for 4 to 6 weeks during which time the soil temperature can reach up to 160°C on the surface and up to 100°C at 75mm deep. Solarisation is by far, the most effective way to kill most weed seeds and seedlings.

Advantages

Good for the environment since there is no pesticides used.

Can kill seeds like Broom seed which can lie dormant in the soil for decades.

No expensive equipment needed

No pretreatment required

Disadvantages

3.4 Herbicide spraying

This involves the spraying of herbicide on to the leaves of the weeds. This can be done with a spray gun and hose from a tank on a vehicle, by a technician with a herbicide backpack or by blanket spraying with a tractor. Herbicide spraying is the most common form of weed control and can be applied to large areas quickly with little labour. To avoid contamination, herbicides must be used with great care along waterways (rivers, lakes, etc.) and where groundwater levels are near the surface. Spraying where there are people and animals should be done carefully as they may be subjected to herbicide spray drift. Early in 2015 the World Health Organisation (WHO) labelled glyphosate (the most common herbicide) as "probably carcinogenic to humans"(IARC, 2015) after a report from the International Agency for Research on Cancer (IARC) (Guyton et al., 2015).

Advantages:

Very effective

Provides long-term weed control

Less labour intensive than some weed control methods

Disadvantages:

Expensive,

Repeated applications are necessary to keep weeds under control

Toxic

Can cause health damage to humans and animals

Chemicals can leach into the waterways

3.5 Stem injection

This method involves cutting or drilling through the bark into the sapwood tissue of the trunks of woody weeds and trees (e.g Willow, Woolly nightshade). Herbicide is then injected or placed into the hole. Once the herbicide reaches the sapwood layer just under the bark (the cambium

growth layer), it is transported throughout the plant. By using the stem injection method there is less chance of the herbicide spilling out into the soil. This is a very selective way of applying herbicides, and allows more discretion as to which plants are killed.

Advantages:

Avoids over spraying of large plants

Useful for trees or shrubs where they might cause damage to surrounding vegetation or their removal is difficult

Disadvantages:

It opens up areas to light which can trigger weed germination.

Falling branches can become a hazard as the parent tree dies and rots

3.6 Hot water

Water is essential for plant growth and reproduction, by it can also be used to kill weeds. Hot water when poured directly on weeds produces immediate results. The plant and root tissues are destroyed by the heat, causing instant shock. Within a day or two, the plant withers and dies. Hot water works well for garden paths, walkways and driveways. Any weed seeds the hot water touches will be killed, with boiling water killing the seeds that may lay dormant in the soil. Hot water can be used to kill weeds naturally, safe and cheap. Boiling water can be applied as follows:

Advantages

Is chemical free

Water is abundant (often where weeds are an issue)

Disadvantages

Requires specialist equipment

Significant setup costs

3.7 Salt

Salt is very effective at killing plants but can also make the ground unsuitable for future plant growth. Salt works by disrupting the internal water balance within the cells of the plant and ultimately dehydrates it (Gardening Know how, 2015). A small pinch of table salt can kill a plant by sprinkling it at the base where it is absorbed by the roots of the plant. Salt can also be mixed with water to kill weeds in a commercial scale in lawns or footpaths. It is preferable to apply salt as a solution mixed 2:1 water t

Advantages:

Does not contain toxic chemicals

Easily applied

Inexpensive

Disadvantages:

Is not plant specific

3.9 Cut and paint (or stump swab)

These methods involve cutting off the weed at its base (no higher than 15cm from the ground) using a chainsaw or an axe and applying herbicide onto the cut stump to kill the root system and the stump.

Advantages:

It is simple to use and poses minimal risk to desirable plants or water.

It requires only small amount of herbicide.

Disadvantages:

Need skilled operators for cutting procedure

Labour intensive as firstly the weed needs to be cut down

4 Future Methods

4.1 Hot Foam

The British company Weedingtech currently has a product on the market called Foamstream, which is essentially the next step from hot water (Weedingtech). Foamstream uses hot water (60°C) and foam to thermally kill weeds by denaturing (breaking) their prun

A New Zealand study looked at the effectiveness of ornamental groundcovers in weed control in a plot trial in Palmerston North, with 12 species planted and monitored for two years. Of these species four were New Zealand Natives. Some plants failed to give year round cover due to frost damage, disease and thinning during flowering. Two of the fastest growing species completely covered the $4m^2$ plots within twelve months (from an initial planting of 3 seedlings). These two were the most effective at preventing weed establishment over the 5-month assessment period. These species were the New Zealand natives; *Acaena inermis* ('Purpurea') and *Muehlenbeckia axillaris* (Foo, Harrington, & MacKay, 2011).

5 Survey on Weed Management in the Transitional City

5.1 Aim

For our Project on weed control methods in the Transitional city we felt that it was important to obtain the opinion of the public on weeds and if they thought there was a problem. The aim was to stop people on the street in the city as they will likely have seen some weeds or at least have seen vacant lots and building sites. It can be difficult to get people to stop and talk on the street so it was decided to keep the survey short by limiting it to 5 questions.

5.2 Methodology

The three members of our group were equipped with name tags, UC identification, a reference letter from the Department of Geography signed by Professor Simon Kingham stating that we were carrying out a research project and a clip board containing our survey questions. Upon arriving at the city we stationed ourselves separately in well-lit areas of high pedestrian traffic

5.3.3 Q3: Should private land owners be required to control weeds on vacant lots?

In talking to Dr Trevor Partridge he pointed out that the Christchurch City Council cannot maintain weeds on private land and the only recourse they have is only if the weeds become a fire hazard, this question was designed to get peoples opinion on that.

5.3.4 Q4: In reference to the picture shown, if this was next door to your house would you feel positive /negative or neutral about it?

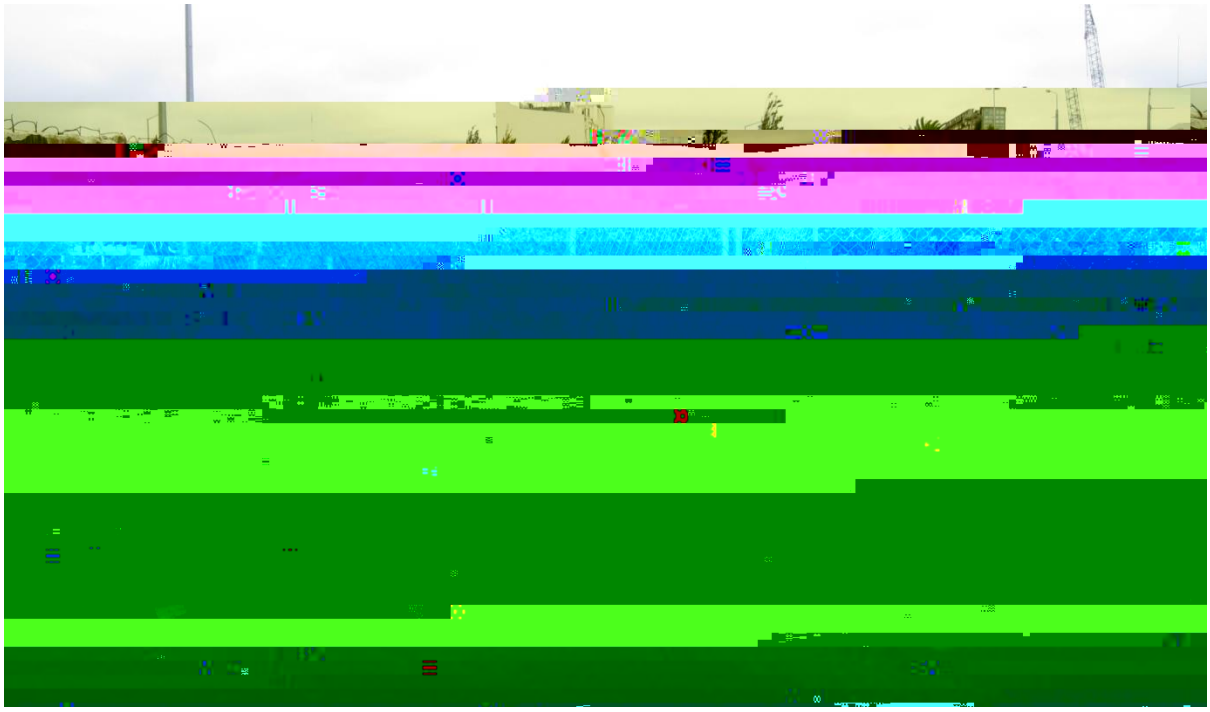

Figure 5 Picture of weeds used for question 4

The photo in Figure 5 was used to clarify in people's minds the kind of weeds we are talking about and to ensure that they were not thinking of a domestic setting with a few minor weeds. Care was given to the wording of the question to reduce the bias placed on the options.

5.3.5 Q5: Please number the following methods in order of preference (with 10 being most favoured and 1 being least)

This question was a two parts as shown in Table 1. Firstly people were asked to rate the methods of weed control from preferred to least preferred. Then after advising people that some methods would involve an increase in resources and therefore an increase in their rates, they were asked what their preferred and least preferred methods are. The list was populated using methods that had been identified as the most familiar and practical.

Methods	Without cost consideration	With cost consideration
Mulch		
Plastic weed mat		
Herbicide spraying		
Vinegar		+
Hot water		+
Organic Herbicide Spraying		+
Natural weed mat		+
Hand weeding		+++
Stem injection of herbicide		+
Steam		++

Table 1 Methods of weed control

+ = a slight increase in resources and costs

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5.4.2 Question 2:

5.4.4 Question 4: If this was next door to your house would you feel positive /negative or neutral about it?

The results for this question closely followed question 3 with 82% of responses saying that they felt negative towards the picture that was shown to them as shown in Figure 9. The 4% positive equates to 3 people.

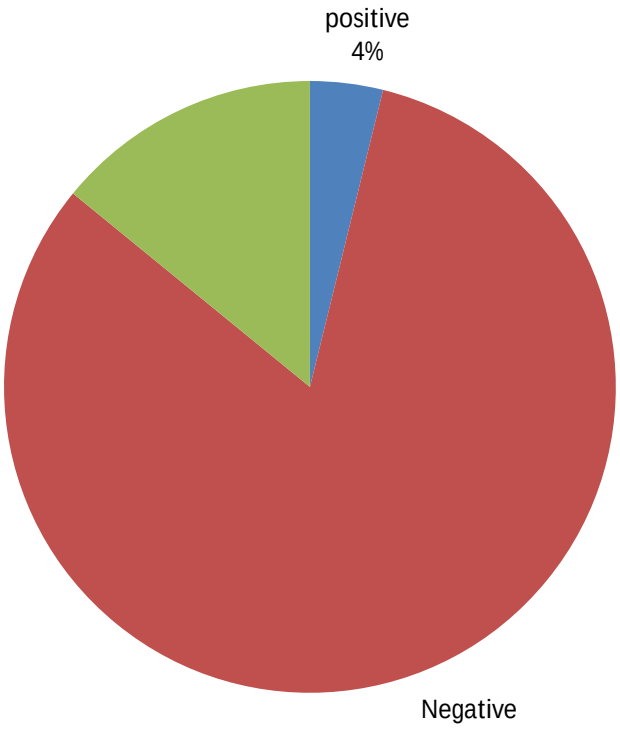

Figure 9 Results graph for Question 4

5.4.5 Question 5

The original methodology was that each method would get a number out of 10, with 10 being there most preferred and 1 being least preferred. In practice this was difficult for people to understand and time consuming so it was simplified to identifying only the most preferred and least preferred methods.

The most preferred method of weed control

As shown in Figure 10, Hand weeding with 24% just beat Mulch at 22% to be the most preferred with no cost influence. Hand weeding dropped to 3rd place after cost information was included with 19%, and Organic Herbicide Spraying and Mulch moving up to tie for first place on 27%.

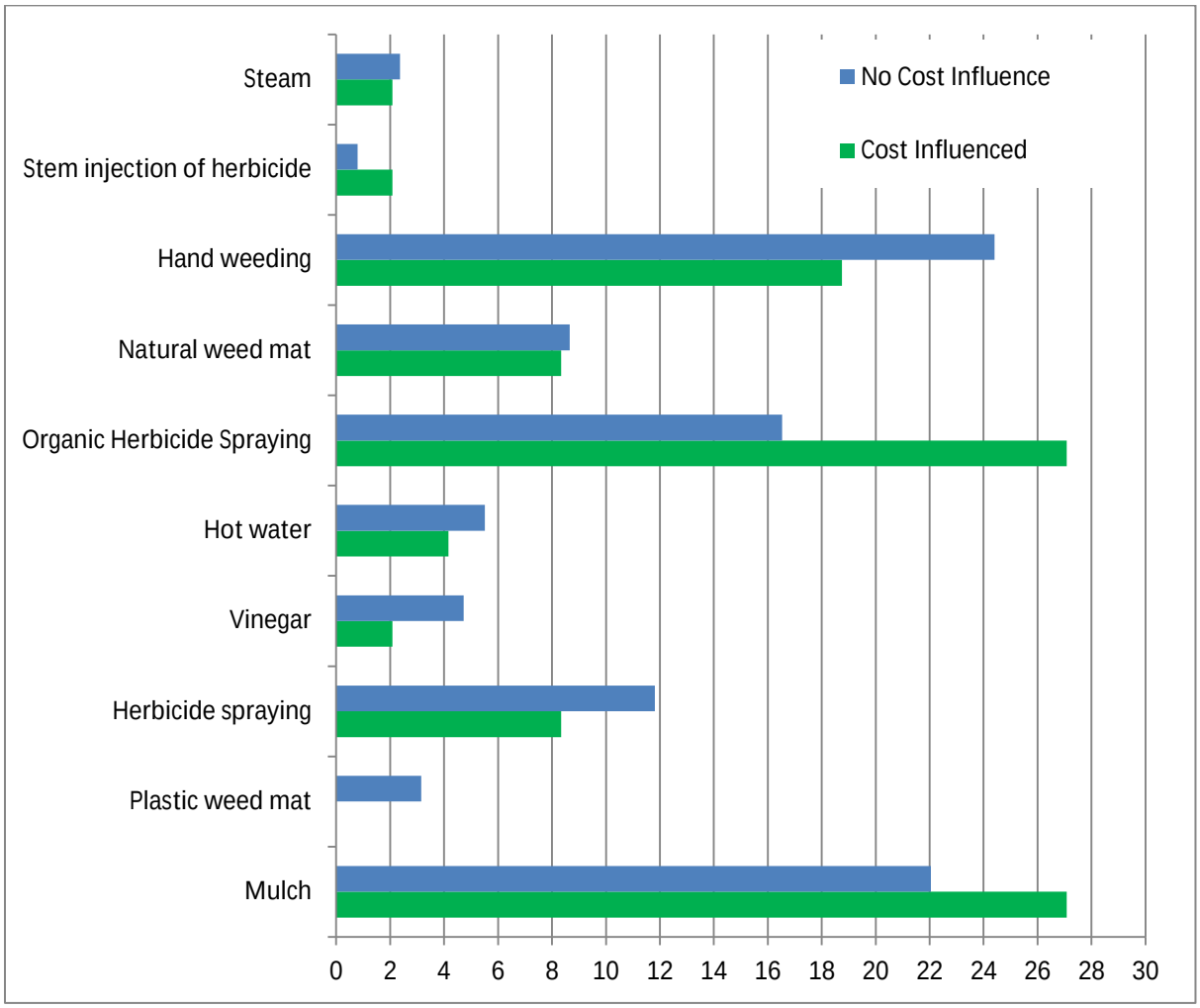

Figure 10 Graph of preferred methods of weed control

The least preferred method of weed control

Herbicide spraying was the least preferred with and without cost influence with 38% as shown in Figure 11. Plastic weed mat was the second without cost influence with considerably less votes on just 15%, this marginally increased to 16% with cost influence. The main mover was Hand Weeding, which went from 4th= on 8% to second outright with 18%.

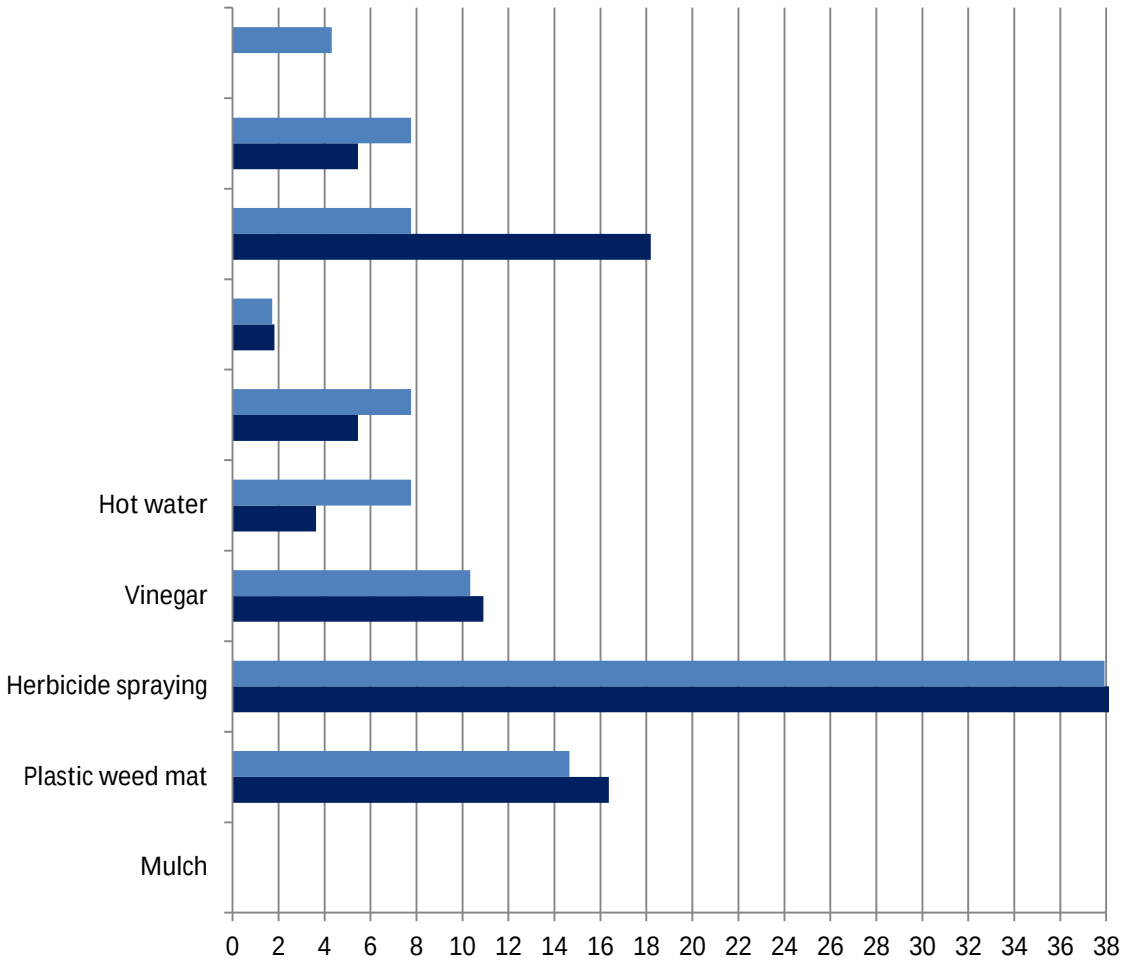

Figure 11 Graph of least preferred methods of weed control

5.5 Discussion

5.5.1 Question 1: Do you think enough is being done to control weeds in the city?

This question stumped a lot of people, many replied that they had not given it much thought, and began scanning around them to see if they could see any weeds. We had positioned ourselves with the intent to be near a lot of foot traffic and thus it was generally a well looked after area. Had we been standing next to an untended vacant lot this could have skewed the results.

5.5.2 Question 2: Should more/less/the same resources be expended on this?

5.5.4 Question 4: If this was next door to your house would you feel positive /negative or neutral about it?

This question was a deliberate follow on from question 3 but used an actual picture to show the extent of the weeds. The surprise here was the number of people who felt that the weeds represented a positive thing. Two people justified their answers with comments of “It shows that

5.6 Limitations and Further Research

7 Acknowledgements

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Trevor Partridge – Christchurch City Council

Christchurch City Park Rangers

Trees for Canterbury

8 References

Braden, D. (2012, 12 March). *Sheet mulch weed barrier.* Retrieved from http://coloradotransitionnetwork.org/photo/sheet-mulch-weed-barrier

Christchurch City Council. (2010). Christchurch City Council Operational Pest Management Plan (pp. 20). Cr

9 Appendix

9.1 Appendix A

Rotofix

9.2

13	1	1		1	1

49	1		1	1		1	10