



Organic Farming: Weed Control in Organic Carrots - Implements

Updated: December 2007

AG1083

ISSN 1329-8062

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Introduction

The production of good quality certified organic carrots is generally seen as difficult. Many growers believe that cost effective, adequate weed control without the use of herbicides is too hard to achieve. However, this is essential for mechanical harvesting and a good yield. The good news is that effective implements exist to achieve a good seedbed and to control weeds for a weed-free carrot crop.

With carrot seed being small (averaging 800 seeds/g), it is important for good crop establishment to sow into a deep, weed-free seedbed of good structure. The slow germination of carrot seed gives weeds a head start. They grow faster than carrot seedlings and compete strongly for nutrients and sunlight in the early stages of crop growth. Unchecked, weed growth during this critical time has the most detrimental impact on yield. Thus, to obtain a good yield and ease of mechanical harvesting, it is essential to control emerging weeds from the time of seedbed preparation until the carrot tops have grown tall enough to shade out weeds. There is a range of soil tillage, bedforming and mechanical weeding implements at the organic grower's disposal to achieve this.

Mechanical tillage and weeding implements

Growers use different types of implements at different times of carrot crop production:

Pre-sowing:

- Various types of tillage implements
- Various types of bedformers
- Weeding implements for first flush of weeds

After sowing – pre-germination of carrots:

- Flame or steam weeder
- Harrow for blind weeding

After germination of carrots:

- Various types of tine cultivators
- Brush weeder
- Row flame weeder
- Hand hoe

Implement descriptions

Pre-sowing

Tillage implements

Either a moldboard plough, disc plough or disc harrow is commonly used in Victoria as the pre-planting tillage implement for carrot seedbed preparation. The mouldboard plough inverts the soil, buries trash, weeds and weed seeds. Its operation is very energy efficient, but needs high draft power (Davies, Eagle & Finney, 1977). The disc plough also penetrates the soil well and inverts the soil. It cuts and covers weeds and trash, and breaks up clods. However, it can also be severe on soil structure. Disc harrows cut up trash and weeds well, but leave some of this trash on or close to the soil surface, which may interfere with carrot crop establishment. Disc harrows can also damage soil structure.

The blade plough is an implement that cuts weeds below the soil surface and leaves them lying on the top of the soil while largely preserving soil structure. It leaves a level bed ready for a final pass with a rotary hoe type bedformer.



Figure 1: Weeds dying on future carrot seedbeds two days after blade ploughing

Bedformers

Tillage with a plough or disc harrow is usually followed by a bedforming operation. A simple bedformer is a frame carried on the 3-point linkage. It pushes the soil from the wheel tracks into the centre of the bed and flattens the soil

to create a uniform, level, full width bed of about 20 cm height.

Rotary hoeing and bedforming in one operation is a time saving alternative to ploughing or discing followed by bedforming. The implement used is a power-take-off driven rotary tiller with curved blades on a horizontal axle, embedded into a bedforming frame. Its advantage is that with one pass, trash and weeds are destroyed extremely well and beds are formed ready for sowing. Disadvantages include the potential for soil pulverisation, destruction of earthworms and other large soil fauna, and the high tractor power demand and energy use involved in operating this implement.



Figure 2: Beds being formed with a rotary hoe bedformer

Weeding implements for first flush of weeds

Fields vary in the types of weeds and size of weed seedbank in the soil. Sometimes it might be advantageous to irrigate the prepared seedbed to initiate the germination of a first flush of weeds. These weeds need to be killed with minimal soil disturbance, so as to prevent bringing fresh seeds to the surface where they will germinate. A shallow cultivation of 2.5 cm to 5 cm depth can be done with a rigid or finger-tine harrow, or a vibrating cutting bar. The latter implement requires a trash-free seedbed. Usually a roller is attached to either weeding implement to crush clods and leave a smooth, flat seedbed for the following crop sowing operation.

After sowing, but pre-emergence of carrots

Carrots usually take longer to germinate than most weeds. This allows the grower to control a flush of weeds after sowing, with either blind harrowing or a flame weeding or a steam weeding equipment, before the carrots emerge. This operation greatly reduces the difficulty of achieving effective weed control after carrot crop emergence. A 3-point linkage flame weeder has several LPG-fuelled burners that cover the whole bed. A steam weeder creates steam and blows it over the weeds. It is safer to use in a dry environment, because there is no danger of setting dry plant material alight. In both cases, the cell structure of the plants is destroyed by high temperatures and the plants die. Flame or steam weeding works best when the weeds are very small. Their great advantage is the control of weeds between the carrots (intra-row), which greatly reduces subsequent hand hoeing. The heat of the flame or steam applied to the soil neither damages the carrot seeds

in the ground nor causes a significant reduction in soil microbial biomass (Rahkonen, 1999).



Figure 3: LPG fuelled flame weeder

After emergence of carrots

Careful soil cultivation between the carrot rows (inter-row) after the carrot seedlings have emerged, controls weeds and also activates nutrient mineralisation and release. The soil disturbance caused by cultivation exposes locked up organic matter and minerals to oxygen, water and microorganisms for decomposition. This may boost crop growth. Weeding implements for this task are best mounted 'underbelly', i.e. underneath the tractor between the front and rear wheels for accurate steering, or equipped with a mechanism such as 'hugboards' or 'bedlockers' that guide the implement along the raised seedbed. These steering mechanisms keep the cultivator over the centre of the bed, and with carefully adjusted tine spacings crop damage is avoided.

Tine cultivators

The traditional and still most common types of weeding implements are tine cultivators. Different shapes and arrangements of tines and blades are used with respect to soil type, stage of weed growth and grower preference. Blade-tine cultivators have a cutting, uprooting and weed covering action and usually give good weed control. However, they tend to leave a furrow and create some soil compaction. A finger-tine harrow (Striegel), consisting of flexible, spring loaded, 5mm diameter round rods on a flexible frame, is soft on soil structure and avoids the drawbacks of the blade-tine cultivator.



Figure 4: Finger tine harrow

However, as it has no cutting action, the finger-tine harrow only works well with small weeds. Also, intra-row weeds are not controlled, as insufficient soil is thrown into the carrot rows to cover emerging weed seedlings.

Rotary-tine cultivator

The Weed-fix[®] is a row-crop tine cultivator consisting of small, flattened rods as tines arranged in circles. These hydraulically driven groups of tines are positioned over the inter-row spaces and rotate to cultivate the soil and uproot the weeds. Working width and depth can easily be adjusted. Adjustable boards to the sides of the rotating tines allow variable amounts of soil to fall into the crop row for intra-row weed control. Compared to the other weeding implements discussed here, the Weedfix[®] is the most adjustable weeding implement that can be used effectively at a greater range of weed and crop growth stages.



Figure 5: Rotary tine cultivator (Weedfix[®])



Figure 6: After weeding cultivation with a goosefoot tine cultivator (left bed) and finger tine cultivator (right bed).

Table 1 shows the weeding results with a goosefoot-tine cultivator, a finger-tine harrow and a rotary-tine cultivator (Weed-fix[®]).

Table 1: Reduction in numbers of carrot seedlings and weeds by three different weeding implements (Mildura 2002)

Goosefoot tine cultivator		Finger-tine harrow		Weed-fix [®]	
Carrots	Weeds	Carrots	Weeds	Carrots	Weeds
67%	83%	33%	82%	0%	80%

Weed control was equally effective to about 80% of weeds killed with all three implements. However, the number of carrot seedlings either covered with soil by the goosefoot-tine cultivator or weeded out with the finger-tine harrow were considerable. This amounted to a substantial yield loss. The performance of the finger-tine harrow would be improved greatly, if a bed-guiding mechanism was attached to the implement.

Brush weeder

An inter-row brush weeder consists of rotating nylon brushes that brush 3-5 cm deep over the topsoil and uproot and destroy small weeds. The brush weeder pictured has vertical nylon brushes mounted on a horizontal axle rotating in the driving direction.



Figure 7: Vertical brush weeder

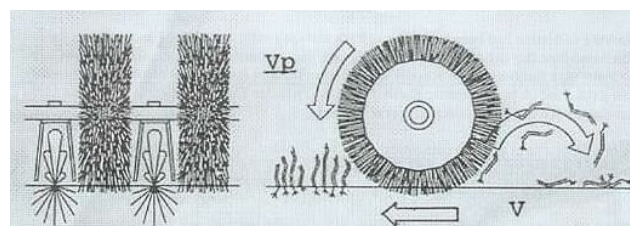


Figure 8: Weeding action of vertical brush

This type of brush weeder is designed to weed closely to the crop to minimise hand weeding, but the brushes do not throw soil into the carrot row for weed control.

Another type of brush weeder has horizontal brushes on vertical axes. The direction of the brush rotation can be selected to either throw soil into the crop row or not.

Inter-row thermal weeders

An inter-row flame or steam weeder that is used when the weeds are very small eliminates any inter-row soil disturbance and thus reduces the potential for bringing new weed seeds to the surface. However, no soil at all is thrown intra-row, i.e. all intra-row weeding must be done by hand.

Hand hoeing

None of the implements used for carrot weeding eliminate hand hoeing between the carrots altogether.

Several types of handheld hoes are available. Most commonly used are various shapes of steel cutting blades on a long wooden handle. A different design is a ‘wire weeder’, which consists of a round steel rod forming a loop at the end of a wooden handle to which it is attached.

The wire weeder is soft on soil structure and crop plants. However, it works best in a light soil and when the weeds are small, as the rod is not sharp enough to cut weeds off.



Figure 9: Hand hoeing with a wire weeder

Conclusion

In the absence of herbicides, implements exist to help organic growers to produce carrots successfully. The pathway to a near weed-free organic carrot crop is:

- long term planning to reduce the weed seed bank
- good seedbed preparation
- pre-crop-emergence blind harrowing or thermal weeding
- one to two weed control cultivations
- one intra-row hand hoeing

References

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Acknowledgments

We acknowledge the funding for this research provided by the Naturally Victorian Initiative, and the support provided by the organic industry.

Figures 7 and 8 have been reproduced with the kind permission of Prof. Nabil Rifai, Nova Scotia Agricultural College, Canada.

This Information Note was originally developed by Christine Jaeger and was published in January 2003

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