Technical
Nursery Papers

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Issue no.11




## The cost of weed control

The cost of weed control in container nurseries is estimated at between $3,700 and $8,470, but may be as high as $96,000 when weeds like bittercress *(Cardamine spp.)* and liverwort *(Marchantia polymorpha)* are present.

To minimise weed control costs, nursery managers need an integrated weed management program, involving an understanding of both the target weeds and available weed management options.

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# Understanding and managing nursery weeds

Weeds cost nursery crop producers by reducing crop growth, competing for nutrients and water, harbouring insect pests and pathogens, and, most importantly, by increasing the cost of production.

Preemergence herbicides are effective on the common nursery weeds, but despite frequent herbicide applications, weeds keep emerging and have to be removed by hand, a labourious and expensive process.

To minimise weed control costs, nursery managers need an integrated weed management program, involving an understanding of both the target weeds and available weed management options.

**Hand weeding can be the largest cost of production. An integrated weed management program can reduce weeding costs.**

### Understanding nursery weeds

Most nursery weeds have:

- Multiple generations per year
- Seed dispersal mechanisms
- Shade-adapted germination and growth

Most nursery weeds are annuals, either winter annual or summer annual, completing their life cycles in one growing season. However, the unique microclimates in container nursery crops (and especially in Australia's climates), blur the distinctions between winter annual and summer annual life cycles.

For example: Spotted spurge *(Chamaesyce maculata)* is typically considered a summer annual but can be present year round in warmer regions. Conversely, common chickweed *(Stellaria media)*, a common winter annual, may be present year-round in shaded, moist areas.

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It is more useful to categorise weeds by whether they are more prevalent in cool or warm conditions. (see Table 1)

Many of these weeds have several common characteristics that contribute to their success in container nurseries including multiple generations per year, a means of seed dispersal within the nursery, and shade-adapted germination and growth characteristics.

**Table 1 (right)**
**Common cool-season or warm-season weeds in US nurseries, based on weed scouting reports from North Carolina and New York (USA) container nurseries; and Australian nurseries.**

| Cool season weeds | Warm season weeds |
|---|---|
| *Cardamine spp.* | *Cardamine spp.* |
| *Conyza canadensis* | *Cyperus esculentus* |
| *Erichtites hieracifolia* | *Digitaria ischaemum* |
| *Marchantia polymorpha* | *Eclipta prostrata* |
| *Oxalis spp.* | *Chamaesyce spp.* |
| *Senecio vulgaris* | *Gnapthalium* |
| *Sonchus spp.* | *Oxalis spp.* |
| *Stellaria media* | *Phyllanthus spp.* |
| **Observed by the author in Australian nurseries during 2003** | |
| *Cardamine spp.* | *Cardamine spp.* |
| *Cerastium vulgatum* | *Chamaesyce hirta* |
| *Conyza canadensis* | *Chamaesyce drummondii* |
| *Crassocephalum crepidioides* | *Crassocephalum crepidioides* |
| *Epilobium ciliatum* | *Chamaesyce (Euphorbia) peplus* |
| *Marchantia polymorpha* | *Oxalis spp.* |
| *Oxalis spp.* | *Phyllanthus spp.* |
| *Sagina procumbens* | *Sonchus spp.* |
| *Sonchus spp.* | |

# Why weeds dominate

## Multiple generations

The first population of weeds to emerge is rarely very large, but once it sets seed, large weed populations build in the nursery, becoming costly and difficult to control.

**Bittercress (flickweed), one of the most common nursery weeds.**

To have multiple generations per year, weeds need limited or no seed dormancy or after-ripening, and need to rapidly reach reproductive maturity.

Little research has been conducted on the reproductive biology of nursery weeds, however observation has shown prolific growth rates.

Hairy bittercress or flickweed *(Cardamine hirsuta)* seeds can germinate within five days and reach 90% germination by 13 days. Similarly, mulberry weed *(Fatoua villosa)* germinates in less than five days, producing viable seeds within 12 days of reaching the two-leaf growth stage. Furthermore, bittercress produces about 2,000 seeds per plant by seven weeks of age. Other rapidly reproducing weeds include woodsorrel *(Oxalis spp.),* common groundsel *(Senecio vulgaris)*, liverwort *(Marchantia)*, and several species of spurge *(Chamaesyce or Euphorbia)*.

## Seed dispersal

Nursery weeds can also spread their seeds by wind or water. Distance of travel depends upon wind speed and direction, but the majority of the wind-dispersed seeds will travel relatively short distances (less than 3 metres).

**Groundsel (left)**

***Oxalis* seedpod (right)**

**Weeds can spread their seeds in different ways. For example the common groundsel seeds are dispersed by wind and float on water.**

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Because many seeds float, you'd expect open drainage ditches in nurseries to provide weed seed transport, but the importance of this hasn't been studied.

Irrigation ponds could also be a significant source of weed seed contamination. However, researchers found that a typical 2.5cm irrigation cycle would contribute only about 38 weed seeds per hectare, which is relatively insignificant.

Rain and irrigation water can splash some weed seeds up to 28cm from soil into pots. Seeds of pearlwort and gemmae of liverwort, for example, are produced in cup-like structures that spread when water drops land on them.

### Copious seed production

Copious seed production also facilitates weed survival and spread. Bittercress can disperse more than 2,500 seeds per plant over a three week period. Mulberryweed produces up to 6,000 seeds per plant, and *Eclipta* produces more than 17,000 seeds per plant in tropical environments.

Most common nursery weeds don't even need light to germinate so they germinate in the shade of crop canopies. Additionally, nursery weeds like bittercress, spurge and chickweed, grow beneath canopies, while others, like willowherb and fleabane *(Conyza canadensis)*, reach above the crop canopy.

**Woodsorrel *(Oxalis)* spreads by rhizomes, stolons and seeds, and can have many generations per year. Red-leafed and green-leafed forms are common.**

# Managing weeds

Before starting an integrated pest management program, first document the pests by weed scouting.

Weed scouting involves building an inventory of the weed species present and noting their relative importance in the production system. You don't need to determine exact population levels.

Information collected in your scouting will enable the nursery pest management operator to continually monitor the effectiveness of the weed management program and to make appropriate adjustments and changes as well as identifying those weed species which aren't being controlled.

### Preemergence herbicides

Although preemergence herbicides form the backbone of most container nursery weed management programs, integrated weed management programs must also emphasise sanitation practices. *Start Clean – Stay Clean*, should be the motto of the weed management program.

Helpful tips include:

- inspect plant materials brought onto the nursery;
- if plants are weedy, remove and discard the top 2 cm of potting substrate before potting;
- regularly monitor the newly potted plants for weeds;
- hand-weed pots frequently (at least every two weeks) to prevent weeds from producing seeds; and
- control weeds around the nursery to prevent them from spreading into your crops.

***Start Clean – Stay Clean.***
**Weed management starts with sanitation.**

The two most commonly used preemergence herbicides in Australian nurseries are Rout (oxyfluorfen + pendimethalin) and Ronstar (oxadiazon). Both of these control a broad spectrum of weeds and are typically applied every eight to 12 weeks, however many nurseries find that, despite frequent applications, weeds still emerge.

Possible reasons for these "weed escapes" include non-uniform herbicide applications, not selecting the most effective herbicide, weeds tolerance, and/or herbicide residues degrading before re-application.

Regardless of which herbicide you use, weed control will be poor if it is not applied accurately and uniformly – easier said than done. Studies have shown up to 250% variation, from less than half to twice the target dose, within a small production block.

You can apply herbicides more evenly by calibrating your spreader to apply half the labelled dose, then treating the beds twice moving in different directions. Remember, the herbicide cannot control weeds if it is not applied uniformly.

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**Is herbicide resistance a concern?**

Obviously, if one herbicide is used several times a year for several years, certain weeds will become resistant. However, if herbicide use is integrated with hand weeding to remove escaped weeds, this is less likely.

When treating individual pots, spread the herbicide over the surface of the potting substrate as uniformly as possible.

When you rely almost exclusively on a single herbicide, it is normal for other types of weeds to occur. For example: reliance on Ronstar *(oxadiazon)* will likely lead to more chickweed or pearlwort because these weeds are quite tolerant of the herbicide.

Much needed recent research demonstrates that trifluralin *(Treflan)* residues dissipate much more rapidly in soilless nursery substrates than in field soils. The half life of trifluralin was less than five days in the surface of a pine bark-based substrate, compared to half-lives of 19 to 132 days in soils. In pine bark substrates, trifluralin dissipated to inadequate levels within 21 days. These data suggest that herbicides dissipate to ineffective levels before re-application would normally occur. It's not surprising then that weeds emerge. This also highlights the importance of sanitation in nursery weed management programs.

Further research needs to be conducted to clarify the dissipation of nursery herbicides in soilless substrates and to develop ways to make them last longer.

**Weeds reduce crop growth. The Nandina 'compacta' on the left was treated with an effective herbicide, the one on the right was not. Summer grass in the pot for 6 weeks dramatically reduced crop growth.**



## Non chemical alternatives

**Are there alternatives to preemergence herbicides besides hand weeding?**

Yes, but they are not widely available and are more expensive than herbicides.

Recent research has demonstrated that some mulches can control many weeds in containers. Geodisk is a geotextile fabric disk treated with copper to prevent weed seedlings taking hold. In some research trials Geodisk has provided weed control comparable to preemergence herbicides.

Pelleted, recycled newsprint and wool have also been investigated for weed control in containers. Some tests have shown weed control comparable to preemergence herbicides; however in other tests, weeds have germinated on top of the mulch.

Several other mulches, such as cocoa hulls, have been used to suppress liverwort in containers, but the cost of these alternatives may be five times higher than traditional herbicides. So they will probably only be practical in sensitive environments or in crops where no safe preemergence herbicides are available.

## The bottom line

A successful nursery weed management program integrates sanitation, exclusion, preemergence herbicides, and frequent hand weeding to control and prevent weeds. And, despite the seemingly high costs for herbicides and labour, research has shown that such integrated approaches will reduce overall costs while protecting nursery crops from weed competition.

| Mulch and depth (mm) | Percent control, by species | |
|---|---|---|
| | **Spurge** ***(Chamaesyce maculata)*** | **Summergrass** ***(Digitaria sanguinalis)*** |
| PennMulch (pelleted, recycled newsprint) 6 mm | 53 | 0 |
| PennMulch, 12 mm | 10 | 25 |
| Wulpak (pelleted, wool) 6 mm | 98 | 53 |
| Wulpak, 12 mm | 100 | 100 |

**Table 2. Comparison of two pelleted mulches for weed control in containers. Weed seeds were placed on the potting substrate surface before mulching.**

## Further reading

Neal, J.C. and I. Gordon. 2003. *Common Weeds of Container Nurseries and their Control*. Centre for Native Floriculture, Univ. of Queensland. 8 pp.

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## Acknowledgement

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