

General information

How to conduct a weed trial

1. Decide which chemical/s or treatments (e.g. coir discs) you want to test.
2. Use a range of plants that you grow, e.g. an acid-loving plant; a plant that is in the production system for a long time; a strappy plant (monocotyledon); a plant with leaves obscuring the pot surface. This ensures that any adverse reactions are found.
3. Use a sufficient number of replicates per chemical/treatment. This will mean 10 pots of each plant per chemical/treatment. Ten is the minimum number. If this number is too large, don't reduce replicate numbers, instead reduce the number of chemicals/treatments tested at once.
4. Ensure you also have 10 replicates for your "control" pots (i.e. where no chemical/treatment is applied).
5. Randomise the pots and keep them in this order throughout the trial. This ensures that any effects (such as shading) are spread across all treatments. Numbering pots may help.
6. Using colour-coded pots per treatment makes for easier application of treatments and avoids losing/misplacing labels. Also ensure that all plants are in the same sized pots.
7. Inoculate pots with the same amount of weed seed per pot and wait for the weeds to grow to a suitable size before applying treatments.
8. Set up your trial in a separate part of the nursery so no contamination occurs.
9. Apply chemical treatments as per the label.
10. Record results weekly (% weed cover; whether weed is dead or not) – ideally by the same person so no bias occurs. Also note the health of the wanted plant as well as the weed. Use a scoring system for wanted plant health (0 = dead; 1 = unhealthy; 2 = moderately healthy; 3 = very healthy).
11. Enter all data into Excel to obtain averages for each result.

OH&S for weed treatments/safe chemical usage/hygiene

[Below is some Disclaimer info that Virginia has written about chemical use]

Disclaimer

The chemicals listed here were correct at the time of research (2020). More current information and the safe use of chemicals is the user's responsibility. Any listed chemicals or treatments do not imply NGIV or UoM endorsement of a particular product. Similarly, any chemical not listed for control does not imply a criticism of that product. Our aim was not to provide an exhaustive list of herbicides for the control of each crop, but instead to give a couple

of examples spanning at least two herbicide groupings so that the necessary and important rotation of herbicide groups can be made to reduce the likelihood of weed resistance to a particular herbicide. Some herbicide groups will show resistance after as few as four years of use (Group B) or more than 20 years (Group I). Herbicide resistance is constantly developing and it is suggested that growers regularly consult the International Herbicide-Resistant Weed Database online at: <http://www.weedscience.com/Pages/Species.aspx> for the latest information.

Disposal of weeds

After weeding, transport weeds promptly and securely to an enclosed disposal area that is downwind from production areas. Make sure weeds are covered when transporting and do not leave them lying in the nursery after weeding. This is particularly important for weeds such as Flickweed (*Cardamine flexuosa*) where seeds are dispersed explosively ('flicked') up to 5 metres. Remove disposed piles of weeds from site promptly to reduce likelihood of weed, pest or disease spread.

Composting of weeds in a production nursery system is not recommended, e.g. some weeds have propagules that may not be destroyed during composting (bulbils of *Oxalis* spp.) and may also harbour diseases. Also, the work required to ensure and document weekly that compost made on site attains the required heat, pH and EC levels in order to destroy any propagules and/or pathogens may not be worth the effort involved (see NIASA Best Management Practice Guidelines, 2018).

Additionally, some weeds may have allelopathic properties (e.g. Spurge, *Euphorbia maculata*) which can inhibit plant germination and growth. These properties can be retained after material is composted – another reason not to compost weeds in a nursery system.

Table 1 below contains information about a weed's common and scientific names, plant family, its life cycle type and whether it is a cool or a warm season weed.

We have provided photos of each weed in this guide. If further photos are required for identification, the Flora of Victoria online contains excellent images of the weeds, see: <https://vicflora.rbg.vic.gov.au/flora/taxon/6ac11352-70de-11e6-a989-005056b0018f>

ASTERACEAE

Laphangium luteoalbum (syn. *Helichrysum luteoalbum*, *Gnaphalium luteoalbum*, *Pseudognaphalium luteoalbum*) Cudweed, Jersey Cudweed

Lactuca serriola Prickly Lettuce

Sonchus asper Prickly Sow Thistle

Sonchus oleraceus Annual Milk Thistle, Annual Sow Thistle

Cudweed (*Laphangium luteoalbum* and *Gamochaeta* spp.)

Description/habit: annual or biennial herbs with flattened, often rosette, leaves. Flowering stems to 55 cm high (*L. luteoalbum*) or 35 cm high (*Gamochaeta* spp.) in spring and summer. *L. luteoalbum* stems and leaves are greyish because of numerous soft hairs. Leaves are up to 7 cm long, alternate and narrowly linear, coming to a point and with inrolled margins. Flowers are in clusters of up to 50 per head, yellow and surrounded by papery brown bracts. *Gamochaeta* has a basal rosette of leaves which may or may not wither at flowering, depending on the species. Leaves are up to 7 cm long by 2 cm at the widest point with entire margins, light green above but silvery below because of the numerous appressed hairs on the undersurface. Flowering stems are erect. Flowers are tiny and surrounded by bracts which are either purplish or straw coloured, depending on the species. Flowers spring and summer.

Reproduction: by seed.

Dispersal: Seeds are wind-dispersed (have a 'parachute'-like pappus, similar to dandelions). Seed is also dispersed in water runoff.

Life cycle:

Month	J	F	M	A	M	J	J	A	S	O	N	D
Flowering*												
Growth												
Seed produced												

* main flowering occurs over summer, with some flowering during the cooler months (lighter colours).

Cultural control: remove prior to flower spike and seed production. Coir discs will inhibit germination as seeds need light to germinate.

Chemical control: Glyphosate (Group M herbicide) is effective. Diuron (Group C herbicide) plus amitrole (Group Q herbicide) are effective. Simazine (Group C herbicide) on its own or Dicamba (Group I herbicide) are not effective as they kill the parent plant but do not stop new seedlings emerging. Resistance to paraquat (Group L herbicide) occurred in Queensland in 2015 for *G. pennsylvanica*.

Prickly Lettuce (*Lactuca serriola*)

Description/habit: Summer annual or biennial erect herb to 2 m high. Stems and, to a lesser extent, leaves exude a milky sap when cut and both have spines. Leaf spines are on edges and on underside of midrib vein. Leaves are alternate, blue-green and nearly vertical. Leaf shape varies from undivided to deep, u-shaped lobes. Flowers are pale yellow and dandelion-like, 10-13 mm wide.

Reproduction: by seed. One plant can produce 48,000 seeds. Germination occurs from 5 to >35°C. Plants can regrow if roots are not removed.

Dispersal: Seeds are wind-dispersed (have a 'parachute'-like pappus, similar to dandelions). Seed is also dispersed in water runoff.

Life cycle:

Month	J	F	M	A	M	J	J	A	S	O	N	D
Flowering												
Growth												
Seed produced												

Cultural control: Remove prior to seeding. Seeds are short-lived, so weeding will run down a seed bank over two years. Seeds are surface germinators, so coir discs will reduce germination. When weeding, remove entire plant because it regrows with more branches if slashed or mown.

Chemical control: Paraquat (Group L herbicide) gave 100% control. Dicamba (Group I herbicide) is listed for control. Control is best achieved while plants are young. *L. serriola* is resistant to ALS inhibitors (Group B herbicide) such as chlorsulfuron and metsulfuron-methyl. There are also some resistant biotypes of *L. serriola* to 2,4-D (Group I herbicide) and glyphosate (Group M herbicide) resistance occurred in 2015 in Victoria.

Sow Thistle (*Sonchus oleraceus*)

Spiny Sow Thistle, Prickly Sow Thistle (*S. asper*)

Description/habit: Annual or biennial erect, fleshy, single stemmed plants to 150 cm high, sometimes with a basal rosette of leaves. Stems are sometimes reddish and smooth (*S. oleraceus*) or prickly (*S. asper*), hollow and all plant parts exude a milky sap (latex) when broken. Yellow flowers all year. Leaves clasp the stem and may be thin and dull (*S. oleraceus*) or thick and glossy with spines on leaf margins (*S. asper*).

Note: the plant can be a host for aphids and virus diseases. Leaf miners, nematodes and fungi can feed on *Sonchus* spp., introducing these pests/diseases into a nursery.

Reproduction: Flowers are self-fertile but outcrossing also occurs via bees and flies. A large plant can produce 40,000 seeds. Seeds need light to germinate so won't grow in shady areas. From seed germination to flowering can take as little as 6 weeks. Seeds can germinate year-round from 7°C to over 35°C and there is no dormancy.

Dispersal: seeds are mostly wind dispersed, often landing within 3 metres of the plant but can travel long distances, including by birds, water and adherence to clothing and machinery. Seeds germinate quickly (no dormancy).

Life cycle:

Month	J	F	M	A	M	J	J	A	S	O	N	D
Flowering	Orange	Orange	Orange	Orange	Orange	Orange	Orange	Orange	Orange	Orange	Orange	Orange
Growth	Green	Green	Green	Green	Green	Green	Green	Green	Green	Orange	Orange	Orange
Seed produced	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Orange	Orange

Cultural control: remove plants before seed set. Young plants are easier to remove before the tap root becomes harder to dig out. A broken stem will reshoot. Coir discs on pot surfaces reduce light and hence germination.

Chemical control: Tour® (oxyfluorfen and oryzalin: Group G and D herbicides, respectively) is listed for control either pre- or post-emergence. Indaziflam and Isoxaben (Group O herbicides) are also listed for pre-emergent control, as is the pre-emergent herbicide, oxadiazon (Group G herbicide) which is well-tolerated by a range of nursery plants. Add a wetting agent to stop herbicide running off leaves. *Sonchus* is resistant to glyphosate (Group M herbicide), chlorsulphuron (sulfonylurea group, Group B herbicide, ALS-inhibitors) and 2,4-D (Group I herbicide) in Australia. Both cultural and chemical control is recommended for effective control.

BRASSICACEAE

Cardamine hirsuta (syn. *Cardamine corymbosa*) Bittercress, Common Bitter-cress, New Zealand Bitter-cress, Hairy Bittercress **NOTE: Flora of Vic lists these as two separate species**

Cardamine flexuosa Flickweed, Wood Bitter-cress, Wavy Bittercress

NOTE: EPILOBIUM IS NOW IN THE ONAGRACEAE – SEE BELOW UNDER ONAGRACEAE

Epilobium billardierianum ssp. *billardierianum* Smooth Willow-herb

Epilobium billardierianum ssp. *cinereum* Variable Willow-herb

Epilobium ciliatum Slender Willow-herb, Glandular Willow-herb, Fringed Willow-herb

Epilobium hirtigerum (syn. *E. cinereum*, *E. junceum*) Hairy Willow-herb

*Flickweed, Wood Bitter-cress, Wavy Bittercress (*Cardamine flexuosa*)

*Bittercress, Common Bitter-cress, New Zealand Bitter-cress, Hairy Bittercress (*Cardamine hirsuta*)

*Note: *Cardamine hirsuta* is similar to *C. flexuosa* but found in drier sites than *C. flexuosa*, the latter being more of a problem in nurseries because of damp conditions. However, they are treated the same here: both species are morphologically similar (one difference is the number of stamens per flower); and both species should be removed prior to flowering (and subsequent seed set).

Also note: Clubroot (*Plasmodiophora brassicae*) occurs on *Cardamine* spp. so it is important to remove these weeds if growing ornamental brassicas (e.g. *Alyssum*, *Cherianthus*, ornamental Kale).

Description/habit: an annual (rarely perennial) plant to approx. 50 cm high (*C. flexuosa*) or 35 cm high (*C. hirsuta*). Basal leaves form a lacey rosette; rounded leaves. Small white flowers 4 mm long. Fruit is a long, narrow pod (silique) splitting longitudinally from the base upwards in late winter-spring.

Reproduction: The plants grow quickly during winter/spring. Flowers of *Cardamine* spp. are self-fertile and can produce up to 5,000 seeds per plant. A lifecycle can take as little as 30 days. Seed can remain viable in soil for 7 years.

Dispersal: Seeds (approx. 1 mm long) are forcefully ejected from the pods up to 5 metres away. They do not require wind or rain for dispersal. However, seeds are sticky when wet, so can adhere to footwear, clothing and machinery, further aiding seed spread.

Life cycle:

Month	J	F	M	A	M	J	J	A	S	O	N	D
Flowering												
Growth												
Seed produced												

Cultural control: Hand weed in winter as soon as small plants are seen. Do not wait until stem is clearly evident because seeds can be produced on small (5 cm high) plants. Securely remove weeded plants because seeds can develop on uprooted plants.

Chemical control: Rout® and Tour® (oxyfluorfen and oryzalin: Group G and D herbicides, respectively) are listed as controlling *Cardamine* spp.; glyphosate (Group M herbicide) is not listed for control. Basta® and Kelpie® (glufosinate-ammonium, Group N herbicide) are listed for control, although warnings against contact of droplets or spray with wanted plants are made as it is a non-selective herbicide. Pre-emergent herbicides such as oxadiazon (Group G herbicide) are effective and well-tolerated by a range of nursery plants. Warm humid conditions are recommended for spraying these latter herbicides, but this is unlikely in late winter/early spring when plants are actively growing and forming seed pods. *Cardamine* spp. are resistant to many herbicides.

ONAGRACEAE

Willowherb (*Epilobium billardierianum* ssp. *billardierianum*) Smooth Willow-herb

Epilobium billardierianum ssp. *cinereum* Variable Willow-herb

Epilobium ciliatum Slender Willow-herb, Glandular Willow-herb, Fringed Willow-herb

Epilobium hirtigerum (syn. *E. cinereum*, *E. junceum*) Hairy Willow-herb

Description/habit: Perennial herbs from 0.2 to 2 m high. Narrow, linear leaves, sometimes with a reddish tinge; pink solitary flowers (sometimes white for *E. billardierianum*, a native *Epilobium*) at top of stems. Flower petals fuse into a slender floral tube. Seed capsules are long (up to 9 cm long) and slender and split open longitudinally from top.

Reproduction: Mainly by seed, sometimes by fragments of stems remaining in ground or by rhizomes. Seed mainly germinates in spring, although germination occurs between 4 and 36°C. Plants can go through their life cycle in 9 weeks. Seed readily germinates in low light conditions under leaves of other plants and can germinate in 4 days. One plant can produce 60,000 seeds in a season. Plants are self-fertile.

Dispersal: Seeds are wind-borne with each seed having tufts of hairs to aid dispersal. Water, machinery and clothing can also aid seed dispersal. Seeds are released explosively when pods are ripe, about 4 weeks after flower opening.

Life cycle:

Month	J	F	M	A	M	J	J	A	S	O	N	D
Flowering												
Growth												
Seed produced												

Cultural control: Remove before seed set, especially prior to spring, ensuring that parts of crown are also removed to stop resprouting. Mulching reduces further seed germination.

Chemical control: Do not just rely on herbicides for control of *Epilobium*. Pre-emergent herbicides such as oxadiazon (Group G herbicide) are effective and well-tolerated by a range of nursery plants. Glyphosate (Group M herbicide) is not effective at later stages of growth. In

Europe, *Epilobium* is resistant to atrazine (Group C herbicide), simazine (Group C herbicide) and paraquat (Group L herbicide).

CARYOPHYLLACEAE

Mouse-ear Chickweed (*Cerastium vulgare*, *Cerastium glomeratum*, syn. *Cerastium fontanum* ssp. *vulgare*)

Cerastium fontanum ssp. *vulgare* (syn. *Cerastium vulgare*) Mouse-ear Chickweed

Description/habit: annual (*C. glomeratum*) or perennial (*C. vulgare*) herb up to 50 cm high, 5 white petals to 5 mm long. Petals have a notch at the tip. Leaves variable in shape but often oval with rounded tips, hairy, up to 25 mm long and 10 mm wide. Root system is shallow and fibrous.

Reproduction: by seed. Some stem nodes root when they touch the soil.

Dispersal: seed is dispersed in water, by wind and vehicles.

Life cycle:

Month	J	F	M	A	M	J	J	A	S	O	N	D
Flowering												
Growth*												
Seed produced*												

* main growth and seed production occurs over late winter to early autumn, although it can occur year-round (lighter colours).

Cultural control: remove by hand before seed set. The plant has a weak root system.

Chemical control: some acids such as pelargonic and acetic acid (no herbicide group) are effective as post-emergent herbicides but are non-selective. Dicamba (Group I herbicide) is listed for Chickweed control but which genus is uncertain (e.g. *Cerastium* or *Stellaria*). Amitrole (Group Q herbicide) is listed for control of Mouse-ear Chickweed (*Cerastium* spp).

Chickweed (*Stellaria media*)

Description/habit: annual herb with weak stems, so often prostrate to 60 cm long. A single line of hairs along stems is a diagnostic feature. Flowers white, 3-4 mm long, 5 deeply notched petals, giving the appearance of 10 petals. Leaves bright green, smooth, 30 mm long, oval to oblong with a pointed tip. Root system is shallow and fibrous. Stems sometimes take root at nodes. The plant can harbour viruses, thrips and nematodes.

Reproduction: by seed. Seed production is copious and seeds can live up to 60 years. Seeds germinate on and just below media surfaces but germination is reduced lower than 2 cm. Some remaining vegetative fragments can continue to grow.

Dispersal: most seed germinates close to the parent plant, although ants can transport seeds further.

Life cycle:

Month	J	F	M	A	M	J	J	A	S	O	N	D
Flowering												
Growth												
Seed produced												

Cultural control: remove before flowering by hand weeding or mulching. Solarisation of ground near potted plants is effective, so lay plastic down over summer. Coir discs or mulch on pots can reduce light and hence germination.

Cultural control: remove plants before seed set, ensuring small stems are removed as these may have taken root. Avoid over-watering; use a coarser potting mix because the small seed doesn't germinate when it sifts down lower into the mix.

Chemical control: Organic control using pine oil (680 g/L) when plants have less than 4 leaf pairs. Dicamba (Group I herbicide) is listed for control. Pre-emergent herbicides are recommended for control because even small seedlings have developed root systems that can avoid herbicides, however, the pre-emergent herbicide, oxadiazon (Group G herbicide), is not effective against *S. procumbens*. Post-emergent herbicides will require repeated application.

EUPHORBIACEAE

~~*Euphorbia drummondii* (syn. *Chamaesyce drummondii*)~~ Caustic Weed NOW KNOWN AS
Euphorbia dallachyana

~~*Euphorbia prostrata* (syn. *Chamaesyce prostrata*)~~ Prostrate Spurge DON'T INCLUDE – NSW
(from Sydney and north) & QLD, NOT VIC.

Caustic Weed (*Euphorbia dallachyana*)

Description/habit: a prostrate, perennial herb with stems approx. 20 cm long. Stems are hairless and exude an irritating milky sap (latex) when damaged. Leaves are opposite, blue-green and rounded. Flowers year-round but mostly in summer. Flowers are tiny and in a pair of leaves.

Reproduction: by seed, mostly in spring and summer.

Dispersal and control: as for Spotted Spurge.

Spotted Spurge (*Euphorbia maculata* syn. *Chamaesyce maculata*)

Description/habit: a prostrate, mat-forming, summer growing annual with a tap root. Distinguished by a central red blotch on each rounded, opposite leaf. Some leaves may not have red blotch. Leaves purplish or green and hairy. Stems are many branched and can be up to 90 cm long, often with a pinkish tinge. Stems and leaves release white milky sap (latex) when broken. Small white flowers approx. 1 mm long in summer and autumn.

E. prostrata has similar leaves but without the red blotch. Its stems are reddish and hairy.

E. drummondii does not have spotted leaves. Stems can be green or reddish but are not hairy.

Reproduction: Reproduction is by seed (as for all spurges). Over summer, the seeds have no dormancy period, so continue to seed in pots and surrounding areas. The plant can complete its life cycle in 25 days. Seeds produced in late autumn remain dormant until spring. One plant can produce several thousand seeds. The taproot can be more than 60 cm deep.

Dispersal: Seeds (approx. 1 mm long) are dispersed by wind, water, shoes (seeds are sticky when wet), clothing. Seeds are released explosively in summer; in autumn ants disperse the seed.

Life cycle:

Month	J	F	M	A	M	J	J	A	S	O	N	D
Flowering*	Orange	Orange	Orange	Orange	Light Orange	Light Orange	Light Orange	Light Orange	Light Orange	Light Orange	Light Orange	Light Orange
Growth*	Orange	Orange	Orange	Orange	Light Orange	Light Orange	Light Orange	Light Orange	Green	Orange	Orange	Orange
Seed produced*	Orange	Orange	Orange	Green	Green	Light Orange	Light Orange	Light Orange	Light Orange	Orange	Orange	Orange

* the main period for flowering, growth and seed production is over the warmer months, although it can occur year-round (lighter colours).

Cultural control: remove plants as soon as seen, especially before seed set. Wear gloves because of the irritating white sap. Remove regrowth from broken tap roots as soon as noticed. Mulching can inhibit germination, so consider a mulch or coir disc on pots.

If surrounding areas are infested, clear plastic sheeting for 6 weeks during high summer can reduce seed viability.

Chemical control: Rout® (oxyfluorfen and oryzalin: Group G and D herbicide, respectively) is listed for control (of *Euphorbia prostrata*) but some Victorian growers found it ineffective after potting. Glyphosate (Group M herbicide) is listed for control of euphorbias. Herbicides such as 2,4-D (Group I herbicide) are not effective on larger plants. Resistance to the ALS inhibitor, metsulfuron-methyl (Group B herbicide), occurred in 2014 in the United States. Some non-selective organic herbicides (e.g. Bioweed® or Slasher®) may be effective but care must be taken not to contact wanted plants. Whichever chemical is used will be more effective before the plant sets its copious seed and grows larger.

MARCHANTIACAE

Liverwort (*Marchantia polymorpha*)

Description/habit: a perennial prostrate, spreading green mat with forked branching, preferring moist, shaded positions but will grow in full sun and tolerate dry periods. No flowers or fruit produced.

Reproduction: mostly by asexual gemmae (look like green 'eggs', visible to the naked eye) produced in cup-like structures. Reproduces sexually via microscopic spores produced on stalked umbrella-like structures.

Dispersal: asexual gemmae dispersed by water – rain splash and irrigation water. Sexual spores are dispersed by wind. Asexual gemmae can spread 1.6 metres; lighter spores can spread a

much greater distance. Birds can also disperse spores, as can humans when spores attach to their clothing.

Life cycle:

Month	J	F	M	A	M	J	J	A	S	O	N	D
Asexual reproduction												
Sexual reproduction												
Growth												

Cultural control: hand weeding, especially when young and before gemmae cups are produced. Use coir discs or steamed rice hulls (up to 2.5 cm deep) on pot surface to discourage growth (a dry substrate deters Liverwort growth).

Chemical control: sodium bicarbonate (bicarb soda) dusted on pot surfaces at 24 g/m². Slasher[®] (525 g/L nonanonic acid; no herbicide group) applied at the recommended rate of 70 mL/L. Alternating between the two can provide optimum control and maintain wanted plant health. Rout[®] (oxyfluorfen and oryzalin: Group G and D herbicide, respectively) is listed for control but perhaps incorporate it into potting mix rather than surface application.

OXALIDACEAE

Oxalis, Creeping Oxalis, Wood Sorrel (*Oxalis corniculata*)

Description/habit: annual or perennial low-growing, creeping plant with reddish-brown trifoliate (3-lobed) leaves which can be mistaken for clover. Younger leaves are green, becoming reddish brown with age. Stems are weak and up to 40 cm long. Bright yellow flowers approx. 4 mm in diameter are either below or at leaf level and produced along the horizontal stems. Flowers mainly in warmer months but can be produced year-round. Plants may flower 4 weeks after germination. Seed capsules up to 20 mm long and 3 mm wide are cylindrical, pointed and upright.

Reproduction: this species of *Oxalis* reproduces by seed only, not by bulbils (which occurs in other *Oxalis* species, such as the pink-flowered *O. debilis* var. *corymbosa* or the yellow-flowered Soursob, *O. pes-caprae*). There are up to 50 seeds per pod and about 5,000 seeds produced per plant. Seeds can germinate quickly because they have no dormancy. Plants can also reproduce from root or stem fragments left in the ground after weeding. Stems can root at nodes. *O. corniculata* is self-fertile with fertilisation occurring before the flower opens.

Dispersal: Seed is dispersed explosively from capsules up to 2 m from the parent plant. Seeds are rough and can adhere to pots, clothing and machinery. The plant also spreads by creeping stolons that root at nodes. Because the stems are weak, weeding frequently leaves fragments of plants, potentially at a distance from the initial part of the plant.

Life cycle:

Month	J	F	M	A	M	J	J	A	S	O	N	D
Flowering*												
Growth												
Seed produced*												

* Main period for flowering or seed production is shown in darker colours, although year-round can occur (lighter colours).

Cultural control: Hand weed, particularly before flowering and seed set. Aim to remove root and stem fragments, otherwise plant may regrow. *Oxalis* have deep taproots. Young plants (up to six weeks old) are readily removed. Coir discs on pot surfaces may limit seed germination.

Chemical control: Sulfonyl urea (Group B herbicide) and diuron (Group C herbicide) during active growth, but diuron can damage wanted plants. Top dressing pots (140 mm) with dolomite lime (40 g per pot) inhibits *O. corniculata* seed germination and growth with no effect on two acid-loving plants tested (*Azalea/Rhododendron* and *Pieris*) or below-surface pH. Dicamba (Group I herbicide) is also listed for control. Pre-emergent herbicides such as oxadiazon (Group G herbicide) are effective and well-tolerated by a range of nursery plants.

POACEAE

Summer Grass or Crab Grass (*Digitaria sanguinalis*)

Description/habit: a summer annual, tufted grass from 15 to 70 cm tall. Stems can lie horizontally before flowering and root at nodes. Stems are smooth but leaves have hairs, leaves sometimes have a purplish tinge on edges, leaf blades up to 15 cm long and 15 mm wide. Ligule (membranous appendage where leaf clasps stem) is purple. Flower/seed heads held like fingers (digitate), 2 to 12 per stem and up to 16 cm long. Seed leaves are light green but the true leaves are dark green.

Reproduction: mainly by seed but also by rooting at nodes. One plant can produce up to 150,000 seeds.

Dispersal: seed is dispersed mainly by human activity, e.g. mowing, on shoes if wet.

Life cycle:

Month	J	F	M	A	M	J	J	A	S	O	N	D
Flowering												
Growth												
Seed produced												

Cultural control: remove before seed set because seeds can live for up to three years in the ground. When weeding, ensure rooted stems are also removed. Mulches or coir discs will reduce light and hence, seed germination. Although seeds can germinate from 6 cm depth, significantly more germination occurs at 0.5 to 2 cm deep. Solarisation of areas around pots is effective. Lilac leaf extract significantly inhibited germination, as did *Ginkgo biloba* leaf extracts.

Chemical control:

Corn gluten meal has been used for organic pre-emergent control. Indaziflam (Group O herbicide) is listed for control, as is prodiamine and dithiopyr (Group D herbicides), both being pre-emergent herbicides. Diuron (Group C herbicide) as a pre-/post-emergent herbicide and the post-emergent herbicide, quinclorac (Group I herbicide) are also listed for control. Resistance to Groups A and B herbicides first occurred in Australia in 1993, followed by several other countries world-wide. Resistance to Group C herbicides in countries other than Australia has occurred since 1983.

Winter Grass or Annual Bluegrass (*Poa annua*)

Description/habit: Mostly a winter annual (perennial types unlikely to survive hot, dry Victorian summers), tufted grass between 2 and 30 cm tall with light green, narrow leaves up to 12 cm long and 5 mm wide. Leaf tips are canoe-shaped. Leaves have a membranous ligule (appendage near leaf base where it clasps the stem). Seed heads are greenish white, turning purple at tips with age. They are either erect or lie on ground.

Reproduction: by seed. One plant can produce over 2,000 seeds. Plants are mostly self-pollinated with viable seed being produced within two days of pollination. Seed can germinate year-round if sufficient moisture is available.

Dispersal: Seed dispersal is by wind but also by water or attachment to clothing, footwear, fur or vehicles.

Life cycle:

Month	J	F	M	A	M	J	J	A	S	O	N	D
Flowering												
Growth												
Seed produced												

Cultural control: remove prior to seeding. The seed is relatively short-lived (two years), so regular weeding prior to seed set will reduce the seed bank. Because ploughing works in soil situations, covering pot surfaces with coir discs may reduce germination.

Chemical control: Indaziflam (Group O herbicide) is listed for control as a pre-emergent herbicide. Pre-emergent herbicides such as oxadiazon (Group G herbicide) are effective and well-tolerated by a range of nursery plants. In 2017, resistance to several herbicide groups was reported in Australia, e.g. glyphosate (Group M herbicide), ALS inhibitors (Group B herbicides), Photosystem II inhibitors (Group C herbicides), microtubule inhibitors (Group D herbicides) and endothal (Group Z herbicides).

References:

Disposal of weeds:

For Flickweed distance: Vaughn, K.C., Bowling, A.J. and Ruel, K.J. 2011. The mechanism for explosive seed dispersal in *Cardamine hirsuta* (Brassicaceae). *American Journal of Botany* 98: 1276-1285.

For compost bin info:

Anon. 2009. Want to keep your compost weed-free? Weed Science Society of America. <http://wssa.net/2009/04/want-to-keep-your-compost-weed-free/> Accessed 14 August, 2020.

For NIASA composting info:

Nursery Industry Accreditation Scheme, Australia (NIASA). 2018. *Best Management Practice Guidelines*. Nursery & Garden Industry Australia, Sydney, 7th edition, 224 pp.

For allelopathic properties info:

Yuiqin, C., Hongwei, W., Hongjan, Z. and Wenjing, L. 2009. Allelopathic effects of aqueous extracts from *Euphorbia maculata* L. on several vegetable species. *Chinese Agricultural Science Bulletin* 25(2): 81–84.

For resistance info:

Preston, C., Boutsalis, P., Brunton, D., Kleemann, S. and Gill, G. 2018. Herbicide resistance – where are we, where are we going and what can we do about it. GRDC Update Papers. <https://grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update-papers/2018/02/herbicide-resistance-where-we-are-where-we-are-going-and-what-can-we-do-about-it> Accessed 6 October, 2020.

Cudweed:

For reduced germination by covering seed:

Anon. AgPest from agresearch. Cudweeds. <http://agpest.co.nz/?pesttypes=cudweeds> Accessed 30 September, 2020.

For *Gamochaeta pensylvanica* paraquat resistance:

Heap, I. 2020. The International Herbicide-Resistant Weed Database. Online. www.weedscience.org Accessed 30 September, 2020.

Lactuca:

For seed production and herbicide control:

Wu, H., Shephard, A. and Hopwood, M. 2019. Prickly lettuce ecology and management. GRDC Update Papers. <https://grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update-papers/2019/02/prickly-lettuce-ecology-and-management> Accessed 16 September, 2020.

For 2,4-D resistance and glyphosate ineffectiveness:

Burke, I.C., Yenish, J.P., Pittmann, D. and Gallagher, R.S. 2009. Resistance of a prickly lettuce (*Lactuca serriola*) biotype to 2,4-D. *Weed Technology* 23: 586-591.

Heap, I. 2020. The International Herbicide-Resistant Weed Database. Online. www.weedscience.org Accessed 17 September, 2020.

Sonchus:

For resistance to some herbicides:

Nagalingam, K., Rafter, M., Ireland, K., Hunter, G., Morin, L. and Sathyamurthy, R. 2018. Response of common sowthistle, *Sonchus oleraceus* to simulated herbivory. In: Australasian Weeds Conference, 9-12 September 2018; Sydney. The Weed Society of New South Wales Inc., p. 33.

For resistance to ALS inhibitor herbicides:

St John-Sweeting, R.S., Preston, C., Baker, J., Walker, S. and Widderick, M. 2010. Genetic diversity among ALS-inhibiting herbicide resistant and susceptible populations of *Sonchus oleraceus* L. (sowthistle) in Australia. In: Seventeenth Australasian Weeds Conference New Zealand, 32: pp. 281-284.

For using both cultural and chemical control:

Chauhan, B.S., Widderick, M., Werth, J. and Cook, T. 2015. Northern IWM Factsheet Common Sowthistle (*Sonchus oleraceus* L.): Ecology and Management. The State of Queensland, Department of Agriculture and Fisheries, 4 pp.

For description:

Widderick, M. and Walker, S. 2009. Management of common sowthistle. Fact Sheet. Department of Employment, Economic Development and Innovation, Queensland Government, 4 pp.

Cardamine:

For self-fertile:

Mandáková, T., Marhold, K. and Lysak, M.A. 2014. The widespread crucifer species *Cardamine flexuosa* is an allotetraploid with a conserved subgenomic structure. *New Phytologist* 201: 982-992.

Vaughn, K.C., Bowling, A.J. and Ruel, K.J. 2011. The mechanism for explosive seed dispersal in *Cardamine hirsuta* (Brassicaceae). *American Journal of Botany* 98: 1276-1285.

For herbicide resistance:

CABI. 2020. *Cardamine flexuosa* (wavy bittercress). In: Invasive Species Compendium, Wallingford, UK. CAB International.
<https://www.cabi.org/isc/datasheet/112949#tosummaryOfInvasiveness> Accessed 15 August, 2020.

For clubroot host:

Tanaka, S., Mizui, Y., Terasaki, H., Ito, S.I. and Sakamoto, Y. 2006. Distribution of clubroot disease of a cruciferous weed, *Cardamine flexuosa*, in major isolated islands, Hokkaido and Okinawa in Japan. *Mycoscience* 47: 72-77.

Epilobium:

For ID:

VicFlora (2020). Flora of Victoria, Royal Botanic Gardens Victoria. <https://vicflora.rbg.vic.gov.au> Accessed 11 September, 2020.

Western Australian Herbarium (1998–). FloraBase—the Western Australian Flora. Department of Biodiversity, Conservation and Attractions. <https://florabase.dpaw.wa.gov.au/> Accessed 11 September, 2020.

For dispersal:

Agriculture Victoria. 2020. Victorian Resources Online. Giant Willow Herb (*Epilobium hirsutum*). http://vro.agriculture.vic.gov.au/dpi/vro/vrosite.nsf/pages/weeds_giant-willow-herb Accessed 11 September, 2020.

For seed number produced and germination temperatures:

Altland, J. 2007. Northern willowherb control in nursery containers. Oregon, USA: Oregon State University. www.cwss.org/uploaded/media_pdf/6473-54_2007.pdf

For not sole reliance on herbicides:

Altland, J.J. (nd) Northern willow-herb management. http://oregonstate.edu/dept/nursery-weeds/feature_articles/willowherb/willowherb_control_page.htm Accessed 11 September, 2020.

For glyphosate tolerance:

Western Australian Herbarium (1998–). FloraBase—the Western Australian Flora. Department of Biodiversity, Conservation and Attractions. <https://florabase.dpaw.wa.gov.au/> Accessed 11 September, 2020.

For resistance to several herbicides:

CABI. 2020. *Epilobium ciliatum* (northern willowherb). In: Invasive Species Compendium, Wallingford, UK. CAB International. <https://www.cabi.org/isc/datasheet/114114#5319EEF2-3822-4C43-8553-EA1847B4D281>

Cerastium:

For chemical control:

Turf Tips. (nd) Mouse-ear chickweed. <https://turf.purdue.edu/mouse-ear-chickweed/> Accessed 14 September, 2020.

Stellaria:

For reproduction and pests:

CABI. 2020. *Stellaria media* (common chickweed). In: Invasive Species Compendium, Wallingford, UK. CAB International. <https://www.cabi.org/isc/datasheet/51635> Accessed 16 September, 2020.

For info on pests and herbicides:

Wilén, C.A. 2006. Chickweeds. Pest Notes. Publication 74129. University of California, Davis. Agriculture and Natural Resources. 4 pp. Also at <http://ipm.ucanr.edu/PMG/PESTNOTES/pn74129.html> Accessed 16 September, 2020.

For ALS-inhibitor herbicide (Group B) resistance:

Kudsk, P., Mathiassen, S.K. and Cotterman, J.C. 1995. Sulfonylurea resistance in *Stellaria media* [L.] Vill. *Weed Research* 35: 19-24.

Sagina:

For rooting at nodes:

Richardson, F.J., Richardson, R.G. and Shepherd, R.C.H. 2011. *Weeds of the South-East. An Identification Guide for Australia*. 2nd edition. R.G. & F.J. Richardson, Meredith, Victoria.

For coarse substrate:

Altland, J. (nd). Pearlwort control with preemergent herbicides. http://oregonstate.edu/dept/nursery-weeds/research/container_trials/pw.htm Accessed 14 September, 2020.

Euphorbia:

Agriculture Victoria. 2020. Victorian Resources Online. Spotted Spurge (*Chamaesyce maculata*). http://vro.agriculture.vic.gov.au/dpi/vro/vrosite.nsf/pages/weeds_spotted-spurge Accessed 16 August, 2020.

Molinar, R.H., Cudney, D.W., Elmore, C.L. and Sanders. A. 2009. Spotted spurge and other spurses. Integrated pest management for home gardeners and landscape professionals. *Pest Notes*. University of California, Davis, Publication 7445: 4 pp.

Liverwort:

Altland, J. and Krause, C. 2014. Parboiled rice hull mulch in containers reduces liverwort and flexuous bittercress growth. *Journal of Environmental Horticulture* 32: 59-63.

England, J. and Jeger, M. 2006. Liverwort gemmae dispersal: the effect of overhead irrigation and its influence on gemma production. *Proceedings of the Sixtieth Annual Meeting of the Northeastern Weed Science Society* 60: 24 (Abstract only).

Lewis, L.R., Behling, E., Gousse, H., Qian, E., Elphick, C.S., Lamarre, J.F., Bêty, J., Liebezeit, J., Rozzi, R. and Goffinet, B., 2014. First evidence of bryophyte diaspores in the plumage of transequatorial migrant birds. *PeerJ* 2: e424.

Mathers, H. n.d. "Weeds just want to have fun!!!" or why are these 10 common container weeds so common: Part 1. 11 pp.

Oxalis:

Doust, L.L., MacKinnon, A. and Doust, J.L. 1985. Biology of Canadian weeds. 71. *Oxalis stricta* L., *O. corniculata* L., *O. dillenii* Jacq. ssp. *dillenii* and *O. dillenii* Jacq. ssp. *filipes* (Small) Eiten. *Canadian Journal of Plant Science* 65: 691-709.

Flora of Victoria. *Oxalis corniculata*. <https://vicflora.rbg.vic.gov.au/flora/taxon/03e89a07-eece-441a-b2c5-ccdb949c862a> Accessed 14 August, 2020.

Wada, S., Altland, J., Mallory-Smith, C. and Stang, J. 2006. Effect of dolomitic lime rate and application method on substrate pH and creeping woodsorrel establishment. *Journal of Environmental Horticulture* 24: 185-191.

Digitaria:

For seed info, cultural and organic control:

Anon. AgPest from agresearch. Summer grass, *Digitaria sanguinalis*. <http://agpest.co.nz/?pesttypes=summer-grass> Accessed 6 October, 2020.

CABI. 2020. *Digitaria sanguinalis* (large crabgrass). In: Invasive Species Compendium, Wallingford, UK. CAB International. <https://www.cabi.org/isc/datasheet/18916> Accessed 6 October, 2020.

Hwang, S.J., Shin, D.H. and Kim, K.U. 1997. Identification of biologically active substances from lilac (*Syringa vulgaris* L.). *Korean Journal of Weed Science* 17:334-344.

Molinar, R.H. and Elmore, C.L. 2010. Crabgrass. Integrated pest management for home gardeners and landscape professionals. *Pest Notes*. University of California, Davis, Publication 7456: 5 pp.

Nam, S.J., Kim, K.U., Shin, D.H. and Hwang, S.J. 1997. Identification of biologically active substances from *Ginkgo biloba* L. *Korean Journal of Weed Science* 17: 421-430.

Wang, Y.H., Ma, Y.L., Feng, G.J. and Li, H.H. 2018. Abiotic factors affecting seed germination and early seedling emergence of large crabgrass (*Digitaria sanguinalis*). *Planta Daninha* 36: e018166895, 10 pp.

For resistance:

Heap, I. 2020. The International Herbicide-Resistant Weed Database. Online. www.weedscience.org Accessed 30 September, 2020.

Preston, C., Boutsalis, P., Brunton, D., Kleemann, S. and Gill, G. 2018. Herbicide resistance – where are we, where are we going and what can we do about it. GRDC Update Papers. <https://grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update-papers/2018/02/herbicide-resistance-where-we-are-where-we-are-going-and-what-can-we-do-about-it> Accessed 6 October, 2020.

Poa:

For seed production:

CABI. 2020. *Poa annua* (annual meadowgrass). In: Invasive Species Compendium, Wallingford, UK. CAB International.

For year-round germination:

Anon. AgPest from agresearch. *Poa annua*. <http://agpest.co.nz/?pesttypes=poa-annua> Accessed 2 October, 2020.

For herbicide resistance:

Heap, I. 2020. The International Herbicide-Resistant Weed Database. Online. www.weedscience.org Accessed 2 October, 2020.

Table 1

The 21 most problematic weeds for the Victorian nursery industry

(determined by responses from NGIV grower survey in 2015)

Common name	Scientific name	Family	Life cycle	Season
Bittercress	<i>Cardamine flexuosa</i>	Brassicaceae	Annual	Cool
Flickweed	<i>Cardamine hirsuta</i>	Brassicaceae	Annual	Cool
Common mouse-ear chickweed	<i>Cerastium vulgare</i>	Caryophyllaceae	Perennial	Cool
Summer grass	<i>Digitaria sanguinalis</i>	Poaceae	Annual	Warm
Smooth Willowherb	<i>Epilobium billardierianum</i>	Onagraceae	Perennial	Cool
Slender Willowherb	<i>Epilobium ciliatum</i>	Onagraceae	Perennial	Cool
Hairy Willowherb	<i>Epilobium hirtigerum</i>	Onagraceae	Perennial	Cool
Spurge	<i>Euphorbia dallachyana</i>	Euphorbiaceae	Perennial	Warm
Spotted spurge	<i>Euphorbia maculata</i>	Euphorbiaceae	Annual	Warm
Red caustic weed	<i>Euphorbia prostrata</i>	Euphorbiaceae	Annual	Warm
Prickly lettuce	<i>Lactuca serriola</i>	Asteraceae	Annual or biennial	Cool
Cudweeds	<i>Gamochaeta</i> spp.; <i>Laphangium luteoalbum</i>	Asteraceae	Annual or biennial	Cool & Warm
Liverwort	<i>Marchantia polymorpha</i>	Marchantiaceae	Perennial	Cool & Warm
Creeping Oxalis	<i>Oxalis corniculata</i>	Oxalidaceae	Annual or perennial	Warm
Winter grass	<i>Poa annua</i>	Poaceae	Annual	Cool
Pearlwort	<i>Sagina apetala</i>	Caryophyllaceae	Annual	Cool
Pearlwort	<i>Sagina procumbens</i>	Caryophyllaceae	Perennial	Cool & Warm

Chickweed	<i>Stellaria media</i>	Caryophyllaceae	Annual	Cool
Mouse-ear chickweed	<i>Cerastium vulgare</i>	Caryophyllaceae	Perennial	Cool
Prickly sow thistle	<i>Sonchus asper</i>	Asteraceae	Annual	Cool
Sow thistle	<i>Sonchus oleraceus</i>	Asteraceae	Annual or biennial	Cool & Warm