Pigweed

Portulaca oleracea

Weed management guide for Australian vegetable production

INTEGRATED WEED MANAGEMENT

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Identification

Pigweed (*Portulaca oleracea*) is an annual, succulent herb. It is native to either South America or North Africa, and features a thick tap root with many fibrous secondary roots, forming a prostrate mat of up to 60 cm in diameter.

Figure 1 Life stages, from germination to flowering.

The stem of pigweed is often reddish, succulent, and commonly with several degrees of branching observed from the main stem. Leaves are alternate and are often clustered at branch tips. They are smooth, succulent, thick, shiny, and are narrow at the base with broad, rounded ends, ranging from 2 to 13 mm in width and 4 to 28 mm in length. Flowers are pale yellow, around 4 mm long, and comprised of 4 to 6 petals. Fruit is a globular pointed capsule, 4 to 9 mm in diameter, and contains many tiny brown to black seeds, which are shiny and 0.5 to 0.8 mm in diameter.

Pigweed is also sometimes known as 'purslane'. It is a distinctive weed species and most vegetable farmers will be familiar with it, however it may be possible to confuse it with 'giant pigweed' (*Trianthema portulacastrum*), particularly soon after germination. Also known as black pigweed, this species is considered a native of tropical areas, and in Australia is largely found in the Northern Territory, Queensland, and northern New South Wales. As an adult plant, giant pigweed may be distinguished from pigweed by its more rounded, crinkled leaves and pink flowers.

Figure 2 Giant pigweed seedling and mature plant.

Characteristics

Key characteristics

Table 1 Key characteristics of pigweed

Time of germination	Late spring to summer
Time of flowering and seed set	Summer
Reproduction	Primarily by seed; vegetative reproduction possible from re-rooting stem fragments
Seed productivity	Many thousands of seeds produced per plant
Seed viability	Up to 40 years reported depending on conditions
Optimum germination soil depth	On the soil surface; germination rare below 2 cm in depth
Soil type/s	Favours high fertility soils with moderate moisture, but capable of growing in nearly all soil types. Soil pH range of 5.6 to 7.8 favoured
Competitive advantages	Grows in a variety of soil types and at a range of soil temperatures; favours smooth tilled seedbeds; high seed production; long-term seed viability; capable of reproduction from plant parts

Seasonality

Pigweed maintains its population via seeds which lie dormant over the winter months. Its growing season is usually limited to the hottest 3 to 4 months of the year in southern Australian conditions, but has been observed flowering in northern Australia (for example in the Northern Territory) in June, suggesting that temperature rather than season is key for this weed's growth cycle.

Pigweed usually requires relatively high temperatures for germination, with seedlings emerging once temperatures exceed 24°C, and following rainfall. Plants tend to flower from 4 to 6 weeks after emergence, with several flushes of flowers occurring depending on conditions. Mature seed can be produced within as little as 6 weeks of germination. Pigweed plants are susceptible to lower temperatures, and begin to die in early autumn. The life cycle of pigweed tends to be completed in approximately 2-4 months in both temperate and tropical climates, however it has the potential to grow as a perennial in tropical climates.

Seed production

Reports of number of seeds per plant vary considerably in different studies, though it appears that many thousands of seeds per plant are produced. A study in Canada found that the number of seeds per fruit varied from 2 to 152, with an average of 59. One study found that a single pigweed plant was capable of producing as many as 10,000 seeds. However, in another study it was found that over 6,000 seeds can be produced in the first flush of flowers, and that as many as 240,000 seeds can be produced by a plant in a growing season.

Seed germination and viability

Seed dormancy and longevity is a significant factor in the capacity of pigweed to survive in the soil, with viable seed apparently capable of surviving up to 40 years burial in the soil. Pigweed seeds can tolerate a large temperature range while remaining viable (from -15°C to 50°C).

Temperature is critical to seed germination. In a study of ideal germination temperature ranges, alternating day/night temperatures of 35°C/20°C resulted in much higher rates of seed germination (96%) than a lower alternating temperature range of 25°C/10°C (15%).

Light is also critical; a number of researchers have found that practically no pigweed seed germination occurs under darkness, at a range of temperatures. The burial depth of seed is therefore a significant factor in rate of germination. Seedling emergence has been found to be greatest at the soil surface, and declining exponentially with increasing soil depth (0.2 cm, 0.5 cm, 1 cm, 2 cm). In this study, none of the seeds buried at 2 cm depth germinated. However, other studies have found that pigweed seeds may be capable of germination at depths of up to 6 cm. These differences may be due to factors such as soil compaction or soil texture, but also the weed ecotypes from which seeds are collected.

Vegetative reproduction

Pigweed is also capable of vegetative reproduction; that is, broken stem fragments are capable of producing roots to re-establish in the soil. Seeds can continue to ripen for up to a week after a plant has been cultivated or pulled out of the ground.

Soil preference

Pigweed is tolerant of a wide variety of soil types, and may be found growing in poor light soils and in soils with pH ranging from 5.6 to 7.8. However, growth and establishment is particularly favoured in soils with higher nutrient levels, including higher phosphorus and nitrogen. Dense plant germination and growth is also favoured in a smooth soil seedbed.

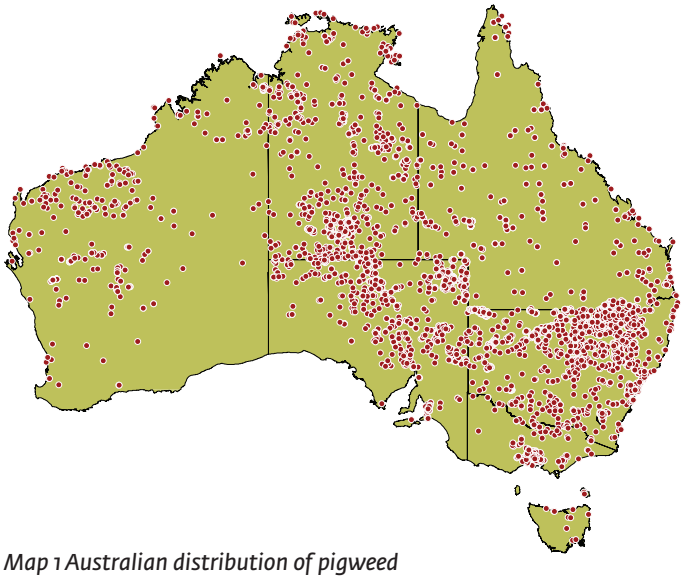
Methods of spread

Pigweed seed generally falls to the ground directly beneath the seed capsules. This means that the plant relies on external methods of spread, including agricultural activities such as cultivation and farm transport. Spread is also possible via animals and birds, and viable seeds have been found to survive animal and bird digestion.

Once pigweed has spread to vegetable fields, populations can increase rapidly. Vegetative fragments can also be spread through normal farm operations, and re-establish in the soil as new plants.

Distribution

Pigweed is a common weed of disturbed sites such as gardens, footpaths and wasteland. It can grow from sea level up to alpine regions in Australia, but is most commonly found in temperate and sub-tropical regions. It is considered a significant weed of cultivation and vegetable production in Australia, particularly in warmer northern climates.



Map 1 Australian distribution of pigweed (source: Atlas of Living Australia)

Figure 3 Rapid germination and early seed production, as well as the high number of seeds produced, make pigweed a significant competitor for vegetable crops and a rapid coloniser of bare disturbed soils.

Impacts

Rapid establishment in crop systems

Because it is capable of producing large numbers of seeds relatively quickly, pigweed is capable of rapidly colonising a site, particularly a disturbed site that has warm, moist conditions. Pigweed has been noted as a serious weed of cropping in over 80 countries around the world, and thrives in cultivation. The capacity of seeds at or near the surface to germinate rapidly following a soil disturbance event (such as tillage) makes it highly competitive with newly sown crops, and it is therefore a common and widespread weed of horticulture.

Crop competition and contamination

In horticulture, yield reductions caused by pigweed can be between 20% and 40% depending on the crop, and previous research has noted pigweed for its specific impacts in asparagus, brassica, tomato and potato crops. In commercial vegetable production, it is capable of limiting summer crop production. It is also capable of establishing new roots from plant parts broken off during tillage or hand weeding, making mature plants in particular capable of re-establishing and providing competition within growing crops.

A host of pests and diseases

In addition to its impacts on yield, pigweed is reported as a host of various crop-damaging organisms, including insects, nematodes, and fungi. Examples include the sugar beet nematode and the tobacco mosaic virus.

Management

Management methods

Table 2 Pigweed management methods

Activity	Suitability	Notes
Tillage	✔ ✔ ✔	Repeated tillage effective when feasible. Timing critical – early in weed lifecycle. Infrequent tillage can contribute to colonisation and spread.
Cover crops	✔ ✔	Thick cover crop canopy can reduce pigweed growth in summer. Effective shading of the crop beds appears to be vital.
Planting density	✔ ✔	Plant crop at highest practical density without impacting on crop yield, to increase competition and shading.
Farm hygiene	✔	Best suited to farms with no current pigweed infestation, or an infestation restricted to one part of the farm.
Physical control	✔	As follow-up to early-stage herbicide and tillage. Hand weeding is expensive and not suitable for wide-scale use. Suited to lighter infestations or occasional larger plants that have not yet dropped seed on the ground.
Herbicides	✔ ✔ ✔	Most effective pre-emergence or early post-emergence. Potential for resistance to certain Group C herbicides.
Mulching and crop residues	✔ ✔	Black plastic film is effective. Organic mulch or crop residue must screen out all light to be completely effective.
Soil solarisation	✔	Effective but expensive and likely to be difficult to implement in annual crop rotation.
Biological control	**N/A**	Not currently available.
Integrated weed management	✔ ✔ ✔	Precise combination of techniques will vary from farm to farm.

Tillage ✔ ✔ ✔

The ability of pigweed plant sections to establish new roots after breakage frequently enables it to survive cultural control practices. However, it has been suggested that early cultivation of seedlings, following irrigation, is effective in reducing pigweed infestations and the seed bank.

Stale seed beds are therefore highly recommended for management of pigweed, providing sufficient time between crops is available for the stale seed bed to be implemented properly. Stale seed beds involve forming the crop beds and then leaving them for a period of time to allow weed seed on or near the surface to germinate and then to be controlled either by repeated shallow cultivation, knock-down herbicide application, or a mixture of both. Research suggests that the ideal length of time to implement a stale seed bed is between 20 and 30 days.

A further recommendation is to allow plant material to dry thoroughly in the field where larger plants have been cultivated before another irrigation is undertaken, to minimise the risk of vegetative reproduction.

More frequent tillage is more effective in reducing the pigweed burden. Pigweed seedling emergence has been found to be significantly greater in a zero-till system compared with minimum tillage plots, where a single cultivation to a depth of 5 cm had been completed 30 days after weed seeds were spread across the plots. Additionally, the time taken for seedling emergence was between 2 and 7 days longer under minimum tillage than under zero-till. Seed burial at a depth of greater than 2 cm across the minimum tillage plots resulted in lower emergence rates than the comparative zero-till plots, where light was available to stimulate seedling emergence.

Different tillage approaches (for example, a deep inversion till) may be used to alter the soil-depth distribution of pigweed seeds and reduce emergence, while germination is likely to be encouraged in zero-till systems where seeds remain on the soil surface. Appropriately timed tillage is an important management tool in reducing the pigweed seed bank, given the preference of this species in germinating on or very near to the soil surface.

Cover crops

Cover crops grown in the period between vegetable cash crops offer growers an opportunity to reduce the impact of pigweed on their farm. They can be expected to reduce pigweed germination, flowering and seed set through competition for resources (soil nutrients, water and light), and potentially as a result of their biofumigant effects.

Selection of cover crop variety will need to take several factors into account, such as cost of and ability to grow the cover crop, its expected soil health benefits, relevance for breaking the disease cycle within the cash crop, and overall contribution to cash crop productivity. Good establishment is critical for achieving effective weed management using the cover crop.

Because available light appears to be critical to pigweed germination, early-season cover crop canopy establishment and cover crop planting density are likely to be important factors in maximising shading and therefore restricting pigweed germination, growth and seed set.

*Figure 5 Rapidly establishing cover crops have been shown to be particularly effective in suppressing pigweed germination and growth due to their high biomass and dense canopy. Here, tillage radish (*Raphanus sativus*) was effective for managing a variety of broadleaf weed species on a farm near Hobart, Tasmania.*

Planting density

Agronomic practices, such as increased plant density, that contribute towards the rapid development of a thick crop canopy cover will result in fewer and shorter pigweed plants, fewer flowers, reduced seed production, and less return of pigweed seed to the soil. This principle is similar to selecting a competitive cover crop variety, as discussed above. Competitive crop variety selection may also result in more rapid establishment of crop canopy, and is likely to have similar effectiveness in suppressing pigweed germination, growth and seeding.

Where it is appropriate to the crop, higher plant density and variety selection (including shading of wheel tracks where this is possible) may contribute to reduced pigweed impact in the longer term.

Figure 6 On this farm near Richmond, New South Wales, appropriate planting density was combined with planting along an east-west axis in an effort to achieve greater shading of the wheel tracks. This can be used along with other techniques (such as tillage, pre-plant/pre-emergent herbicide application and selective hand weeding) to suppress pigweed and other weeds effectively within the crop beds.

Farm hygiene

Implementing appropriate farm hygiene practices helps limit the spread of pigweed seeds and viable plant fragments across and between properties, and onto crop beds from other parts of a property where the weed is present. Common practices include permanent or set vehicle tracks, equipment wash-down bays or designated areas, and restricting movement onto the property.

While pigweed may be well managed within the crop beds, it may still be observed in wheel tracks, headlands and nearby non-crop areas, to the extent that plants were going to seed and replenishing the seed bank in the fields. Effectively managing off-bed pigweed plants may therefore reduce the burden of this weed within crop beds in the longer term.

Farm hygiene may be less relevant for managing pigweed where it has already spread across the whole farm. Other difficulties associated with this approach include the time required to wash equipment down thoroughly, and the potential for uncontrolled spread in flood prone areas.

Figure 7 Establishing a fixed equipment wash-down bay can help restrict the spread of pigweed on the farm, particularly where it is not present at all or only present on part of the farm.

Physical control

Hand weeding is effective for removal of pigweed and other important weeds on vegetable farms, particularly those that are flowering or setting seed, and/or plants missed when other management approaches have been implemented. Options include digging or hoeing plants out, or potentially pulling larger plants out by hand. Hand weeding may be necessary to remove pigweed plants growing close to crop plants, in crop plant holes in a plastic mulch system, or more generally within the crop bed where selective herbicide options are not available, and where other attempts to manage the weed have been less successful.

However, the fleshy stems and leaves of pigweed mean that hand weeding (for example hoeing) can be less effective, as the plant is resistant to desiccation and may re-root from plant sections. Pigweed plants that are flowering should be removed from the crop rather than left on the ground, to ensure that viable seed are not released near the crop rows to add to the soil weed seed bank for future seasons.

Farmers are generally hesitant to implement wide-scale hand weeding due to its high cost. However, selective hand weeding can be a very effective follow-up to tillage and herbicide control in particular, implemented earlier in the crop life cycle. Removing a few remaining pigweed plants by hand and taking plants away from the paddock may have significant benefits in reducing the weed seed bank in future crop seasons. It may also help prevent herbicide resistance from developing.

Figure 8 Removing recently germinated weeds such as pigweed before they have a chance to establish is an effective follow-up to pre-plant tillage and herbicide control, and will have longer-term benefits in reducing the weed seed bank. Tools that require relatively little effort, such as the stirrup hoe pictured here, can make this task easier depending on soil type and moisture level, and weed plant size. Larger pigweed plants are likely to require digging or pulling out, and removal of the entire plant to avoid re-rooting.

Herbicides

A range of selective and non-selective herbicides are registered to control pigweed, across a variety of vegetable crops. Farmers should consult with their advisor or agronomist for specific product availability in their district, whether herbicide options are registered for the crop/s they grow, and the suitability of these products for their production system.

Pre-emergent herbicides are recommended for control of pigweed, however tilling the pre-emergent herbicide too deeply into the soil can result in less effective control. Herbicides must be present on the surface at the time of seedling emergence. Post-emergent herbicides are also considered valuable against young pigweed seedlings. When applied to more mature plants, control can be less effective and may not prevent seed set.

Table 3 Herbicides registered for management of pigweed in Australian vegetable production

Herbicide active ingredient*	Trading name/s	Group	Vegetable crop/s in which registered	Timing/crop stage
Atrazine	Atrazine; Gesaprim	C	Sweet corn, potatoes	Pre-plant, pre-emergence or post-emergence
Chloridazon	Pyramin	C	Red beet, silver beet, baby leaf spinach	Post-sowing pre-emergence
Chlorthal-Dimethyl	Dacthal 900 WG	D	Brassicas, beans, peas, garlic, onions, carrots, lettuce, potatoes, turnips	At time of seedling or transplanting
Clomazone	Command 480 EC; Director	F	Cucurbits, potatoes, green beans, navy beans	Post-plant pre-emergence
Dimethenamid-P	Frontier-P	K	Green beans, navy beans, sweet corn, corn, green peas, pumpkins and kabocha	At or immediately after sowing; pre-emergence
Diuron	Diurex WG	C	Asparagus, peas	Pre-emergence
EPTC	Eptam	E	Beans, potatoes	Pre-emergence
Fluroxypyr	Fluroxypyr	I	Corn	Post-emergence
Ioxynil	Totril	C	Onions	Post-emergence
Linuron	Linuron DF and Flowable	C	Carrots, parsnips, onions, potatoes	Pre- or post-emergence depending on crop
Methabenzthiazuron	Tribunil	C	Onions	Post-emergence (one or more true leaves in onion crop)
Metham	Metham Sodium; Tamafume (fumigants)	N/A	All crops	Biofumigation
Metolachlor	Metolachlor	K	Brassicas, green beans, navy beans, corn	Pre-emergence or immediately after transplanting depending on crop (suppression only)
Oxyfluorfen	Baron 400 WG; Goal; Striker	G	Brassicas	Pre-transplant (7 days prior)
Pendimethalin	Rifle 440; Romper; Stomp 330EC; Stomp 440; Stomp Xtra	D	Carrots, peas, beans, onions, transplanted broccoli, cabbage, cauliflower, processing tomatoes	Pre-emergence
Phenmedipham	Betanal Flow 160 SE	C	Beetroot, silver beet	Post-emergence selective
Prometryn	Gesagard; Prometryn 900DF	C	Carrots, celery, potatoes	Pre-emergence, or early post-emergence in carrots
Propachlor	Ramrod	K	Onions, transplanted brassicas, beetroot	Pre-emergence, pre-transplant or at-transplant, depending on crop
Propyzamide	Propyzamide	D	Lettuce	Pre-emergence or immediately after transplanting
S-metolachlor	Dual Gold	K	Brassicas, beans, sweet potatoes	Immediately after transplanting (suppression only)
Trifluralin	Trifluralin	D	Green beans, navy beans, peas, carrots, brassicas	Pre-sowing or pre-planting

** Details correct at time of writing; please consult the relevant herbicide label/s, contact your reseller for current registration details, or contact the Australian Pesticides and Veterinary Medicines Authority. This table does not include minor use permits, or non-selective options such as glyphosate or diquat. If using crop rotations, the APVMA Public Chemical Registration Information System database may be searched for 'portulaca' to identify a range of herbicides suited to a range of cropping situations.*

Herbicide resistance

Although it does not yet appear to be an issue in Australia, vegetable growers should remain aware of the potential for herbicide resistance to develop in pigweed and other key weeds, particularly if their crop rotation involves heavy reliance on a limited range of registered herbicides. Integrated weed management is of particular importance in reducing the risk of herbicide resistance developing.

Greenhouse experiments have confirmed that pigweed biotypes exist in carrot crops in the United States with resistance to linuron, atrazine, diuron, cyanazine and prometryn. Resistant and susceptible biotypes remained sensitive to hexazinone and bentazone. Notably, of these herbicides, atrazine, diuron and linuron were registered for pigweed management within a variety of Australian vegetable crops at the time of writing.

Mulching and crop residues

Provided they are capable of screening out all light, mulches appear to be effective in reducing emergence of pigweed in crops. To be effective, organic mulches need to be at least 7.5 cm thick, but black plastic mulches that screen out light are also effective.

Researchers in the Philippines have explored the interaction between the amount of crop residue and pigweed seedling emergence in rice production. They found that 2 tonnes per hectare of crop residue reduced seedling emergence by 50% compared with zero-residue, while a heavier residue of 6 tonnes per hectare reduced seedling emergence by 88% compared with the no residue control. Seedling dry matter was likewise significantly reduced in higher residue plots.

This illustrates the potential of crop residue (both cash crops and cover crops) to reduce the impact of this weed when left on the soil surface, in combination with other management methods. In some cases however, this approach may not suit the production system.

Figure 9 Because it requires light to germinate, pigweed can be managed effectively by laying plastic mulch on the crop beds. This option is generally only viable for certain high-value vegetable crops, such as this cucurbit crop near Bundaberg, Qld.

Soil solarisation

Soil solarisation, in the form of covering the crop bed for 4 to 6 weeks with a plastic film during the summer months (when heat and light are highest), has been found to be effective in controlling both pigweed plants and its seed.

Biological control

At the time of writing, research into biological control agents for pigweed management appeared to be inconclusive. In general terms however, biological control agents will only suppress growth and/or flowering of weeds, and will not achieve sufficient control alone. They are no silver bullet for success and therefore need to be integrated with other methods to achieve effective weed control.

In Australia biological control has largely only been introduced for some perennial non-grass weeds in aquatic, pasture, and rangeland habitats. The short-term cropping season common in vegetable production makes it difficult for biological control agents to become established at effective levels. Therefore, vegetable farmers are unlikely to have the benefit of their use in the near future.

Bringing the control methods together

The three dimensions to success, most likely to provide effective control of major weeds such as pigweed include 'Deliberation', 'Diversity', and 'Dedication'.

In applying this '3D' approach, a variety of options is available as described on the next page. This is commonly known as 'integrated weed management', and is likely to bring you the greatest chance of success in restricting the impact of pigweed on your farm.

Integrated management of pigweed

Integrating all available and feasible weed control techniques in a timely and diligent way has been shown to be very effective in bringing heavy infestations of broadleaf weed species such as pigweed under control on Australian vegetable farms.

This section has been adapted from the chapter 'Vegetable Weed Management Systems', written by Craig Henderson, and published in the book *Australian Weed Management Systems* (edited by Brian Sindel, University of New England).

Some practices may be implemented for reasons other than weed management, but still have weed management benefits.

Depending on the farmer's circumstances and resources and the extent of the pigweed infestation, whole-of-farm integrated weed management strategies may include the following:

- Shifting most cash crop production to the parts of the farm where the pigweed infestation is lower.
- Including a cash crop or cover crop during the traditional non-cash crop period in the rotation allows use of *selective herbicide options* that have been registered for pigweed control. Fewer weeds may be expected to appear in the paddock when an out of season cover crop is grown. Including a fallow period in the crop rotation may also allow *non-selective herbicide* application to reduce the pigweed soil seed bank.
- Where a weed infestation is particularly heavy, it may be necessary to produce cash crops only during the coolest months of the year, given that pigweed is a summer weed in many regions. If a summer fallow period or cover cropping period is implemented, it may provide the opportunity to manage pigweed through other means, reducing its longer-term effect on cash crops, and possibly allowing for re-inclusion of summer cash cropping once the pigweed burden has been reduced.
- Implementing and rigorously adhering to a *farm hygiene* program, for example: undertaking thorough vehicle washdown in between farm sites (especially infested and non-infested areas); laying concrete or gravel tracks along major farm laneways to reduce the amount of soil being spread by vehicles; and planting a competitive grass species (e.g. Kikuyu) along laneways and drainage lines, and mowing these areas to minimise the chance of undesirable weed establishment. Farm hygiene reduces the potential for pigweed seeds outside the vegetable beds to act as sources for recolonisation, and is particularly relevant when parts of the farm are infested while others remain free of the weed.
- *Repeated cultivations* and *knock-down herbicides* may be used together to reduce the population of pigweed and other weeds before each crop planting. These approaches may include implementing a stale seed bed, and controlling recently germinated plants either by light tillage or herbicide application. Encouraging seeds to germinate and then controlling the plants before seed set can reduce the weed seed bank in the longer term. Minimal or infrequent tillage is likely to increase the pigweed burden by providing time for weeds to grow and set seed.
- Use of a *drip irrigation system* can mean that the non-irrigated inter-rows remain dry (unless rain falls) throughout most of the growing period, with consequent reductions in pigweed and other weed populations. Such an irrigation system may be integrated with a *plastic mulch* in some high-value vegetable crops such as cucurbits. This will result in little pigweed emergence within the mulched crop beds since this weed requires light to germinate, though farmers need to remain aware of the potential for weed seeds to germinate in the crop holes, as well as where the mulch has been punctured during laying or during crop management activities.
- *Close plant spacings*, *rapid crop growth* and *canopy closure*, combined with in-crop spraying of *selective herbicides* (where such options are available) can result in low survival of pigweed in the vegetable crop. A similar policy may be pursued in cover crop rotations, and has been shown to suppress pigweed effectively due to competition. Thick mulched crop or cover crop residues have also been shown to be effective in reducing pigweed seedling emergence.
- *Hand weeding* also has a role to play in an integrated approach. Farm staff should be encouraged where possible to physically remove and destroy older weeds (particularly those flowering) that they come across in the course of their work, especially at harvest time when large numbers of workers are likely to be systematically moving through each field.

Because annual broadleaf weeds such as pigweed rely in part on rapid turnover of large numbers in the soil weed seed bank to maintain high populations, an integrated management system of this nature can be expected to result in a relatively sharp decline in weed numbers over time. Nonetheless, farmers need to remain aware of the potential for pigweed seed to remain dormant for up to several decades depending on conditions, and therefore for germination flushes to occur at any stage given suitable circumstances.

However, integrated management of pigweed is likely to be effective in reducing its impact at relatively little extra cost to the farmer, given that most of the operations described above would still have been implemented for other reasons and have other farm and crop benefits.

The key to integrated management of pigweed is a planned strategy to link the key management components in a sensible sequence, and the persistence to ensure that each step is diligently carried out. In the longer term, integrated weed management may contribute to improved enterprise flexibility, where cash crops may eventually be grown at any stage of the viable production period without concern that this will result in a vast increase in weed numbers, or that the weed burden will impact too significantly on the cash crop.

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Disclaimer

Descriptions of herbicide use in this guide are not to be taken as recommendations. Herbicides must only be used in accordance with the recommendations provided on herbicide labels. Readers are reminded that off-label use of herbicides may be restricted or not permitted under relevant legislation. Landholders are therefore advised to determine current registrations and legal requirements for herbicides they may be considering, and to consult with their State or Territory government departments regarding the legal requirements they are obligated to adhere to relating to herbicide use and weed control.

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