

The potential for cultural control of *Tribulus*, *Cenchrus* and *Emex* in Sunraysia vineyards

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Summary

Control of *Tribulus terrestris*, *Cenchrus longispinus* and *Emex australis* in Sunraysia vineyards can be achieved by integrating a range of management practices. The emphasis in management in the short term should be on the use of regular cultivation or post-emergent herbicide in the inter-rows and use of pre-emergent herbicides under the vines. Drying green management requires regular use of a prickle roller, with either autumn and spring application of pre-emergent herbicides, regular spot spraying of post-emergent herbicides or rigorous removal of weeds with a shovel.

In the longer term the strategy for *Tribulus*, *Cenchrus* and *Emex* control must be compatible with the move towards more sustainable production and corresponding changes in soil management.

Longer term spiny weed management, inter-row and undervines, will depend on increased adoption of sprinkler irrigation, use of mulches and spot spraying with post-emergent herbicides. Vigilance and regular spot spraying or removal of weeds with a shovel will enable growers to maintain grassed drying greens free of spiny weeds in the long term.

Introduction

Weed control in Sunraysia vineyards is an integral part of a management system dominated by the need to irrigate in summer. Other key vineyard operations are frost control in spring and harvest in late summer. This paper discusses various vineyard management practices and how they can contribute to the development of short-term and long-term strategies for control of *Emex australis*, *Tribulus terrestris* and *Cenchrus longispinus*. Paramount to the development of strategies for short and long-term weed control is the need for flexibility so that programs are feasible within the management constraints of individual growers.

Benefits and limitations of cultural practices for control of *Emex australis*, *Tribulus terrestris* or *Cenchrus longispinus*

Inter-row cultivation

The inter-row is a strip, usually two metres wide, between vine rows. On heavy soils, summer cultivation of the inter-row with a rotary hoe, cultivator, disc plough or blade plough improves soil friability and therefore penetration of irrigation water into the soil.

On sandy soils, clean furrows down the length of an inter-row assist rapid flow of water to the end of the row. On both soil types cultivation assists with evenness of water distribution. In late August, inter-rows are cultivated to incorporate the cover crop or weed growth into the soil and so reduce the risk of frosts during bud burst in September.

From the time of *Tribulus* and *Cenchrus* emergence in October/November until late summer, about 80% of dried fruit growers cultivate the inter-rows prior to irrigating. Although some growers cultivate only before every second or third irrigation, most inter-rows would be cultivated every three or four weeks. These cultivations also serve to kill *Tribulus* and *Cenchrus* before any seed matures on the plants. Thus, few growers would consider *Tribulus* or *Cenchrus* to be 'problem weeds' in the inter-rows.

Emex weed seedlings are easily killed by cultivation. However in the months when *Emex* is most actively germinating, between April and August, inter-row areas are not usually cultivated. Cultivation can only be successfully used to control *Emex* in the inter-row area if it is done monthly or followed up with monthly post-emergent sprays, because *Emex* plants can produce viable seed within 5 weeks of germination.

There are four major problems associated with the use of cultivation as a method of controlling *Emex* or *Tribulus*:

- (i) Frequent summer cultivations will replenish a seed bed from the store of non-germinating, deeply buried seeds.
- (ii) Further germination of *Emex* and *Tribulus* is stimulated by cultivation. April cultivation to incorporate fertilizers and sow a cover crop, or incorporation of winter growth in August for frost control, will stimulate *Emex* and *Tribulus* respectively, causing a wave of *Emex* plants to germinate in April/May and a wave of *Tribulus* in October/November. If growers anticipate this and control the early wave of germinating seedlings, they can eliminate a great proportion of the season's seed store.
- (iii) The edge of the cultivated inter-row strip may become a hazard area, hosting weeds which survive subsequent cultivations and produce mature seeds. Plants surviving on the edge of the inter-row are contributing to the undervine seed-bank and to the risk of spiny weed seed contamination of fruit during harvest.
- (iv) There are high costs associated with use

of cultivation alone to control *Emex* or summer spiny weeds. The seasons for germination overlap, and year-round cultivation would be required of any grower determined to rid the vineyard of the weeds.

Undervine cultivation

There is a metre wide bank under the row of vines in most vineyards in Sunraysia. In many vineyards, the undervine bank is destroyed with a sillyplough in spring or autumn to remove undervine weed growth from the preceding season. A new clean bank is then formed.

Undervine cultivation has benefits to growers who are resurrecting a failed herbicide bank or who are preparing their first clean bank for residual herbicide application. Knifing weed growth during the winter or summer months is useful to reduce the density of hard-to-kill weeds to levels which can then be controlled by herbicides. However, undervine cultivation is only a short-term remedial treatment as it can cause extensive root damage to vines. It has limited application in a program to be recommended to growers for control of spiny weeds.

Cultivation of the drying green

Cultivation would only be recommended for a drying green when the following situation exists: the growth of annual weeds such as *Emex*, *Tribulus* and *Cenchrus* is so dense that application of high rates of pre-emergent herbicides is the most cost effective and sure way of reducing the next seasons infestation, and adequate preparation of the green area for pre-emergent herbicides cannot be achieved by slashing or spraying post-emergent herbicides.

A drying green should be cultivated only in autumn, and the soil rolled down well and allowed to consolidate for a number of months before traffic passes over it. Cultivation must be followed up by application of pre-emergent herbicide to the drying area.

Post-emergent 'knockdown' herbicides

Post-emergent herbicides are used to control *Tribulus*, *Cenchrus* and *Emex* inter-row, undervines and on drying greens. Most commonly used are the non-selective glyphosate and paraquat. Other post-emergent herbicides registered for use in vines are oxyfluorfen, fluazifop, amitrol, diquat, 2,2-DPA and glufosinate-ammonium.

Strategic application of post-emergent herbicides as part of a total control program for spiny weeds is under-utilized by growers in Sunraysia. Post-emergent herbicides are usually applied much too late in the season for successful, cost effective control.

Total weed control using post-emergent herbicides is limited significantly by the costs, in chemical, fuel and time, of applying post-emergent herbicide every five weeks and by the risk of causing herbicide damage to the

vine canopy in summer,

There are, however, direct benefits from the use of post-emergent herbicides as an alternative to cultivation:

- (i) Zero cultivation is made possible by use of herbicides, stopping the replenishment of surface germinating seeds from deeper soil,
- (ii) Fuel and machinery costs are reduced.
- (iii) Vine roots are saved from the destructive action of a knife plough.
- (iv) Weeds on drying greens are very easily managed.

A potential benefit, recognized by very few growers, is that post-emergent herbicides can be used inter-row to 'mow' or stunt cover crop growth and to spray-top a cover crop. This enables growers to use cover crop competition in summer as a means of inhibiting further weed growth while minimizing moisture and nutrient competition to the vines.

Post-emergent herbicides will be included in the industry's long term spiny weed management program. The range of herbicides suitable to apply over cover crops, whether currently registered in vines or not, should be investigated with regard to timing of spray application and chemical rates for top spraying cover crops.

Pre-emergent 'residual' herbicides

An increasing proportion of growers are applying pre-emergent herbicides to undervine banks in autumn and spring. The most commonly applied pre-emergents are simazine, oryzalin and diuron. Other pre-emergent herbicides registered for use in vines are oxyfluorfen, trifluralin, napropamide and norflurazon.

Use of pre-emergent herbicide under vines is often limited to those growers who can incorporate the herbicide with sprinkler irrigation. Furrow irrigators have difficulty getting good incorporation of pre-emergent herbicides into the undervine soil, and so wider adoption of these herbicides has been slow.

Inter-rows are not treated with pre-emergent herbicides in summer and rarely in winter. During summer, vehicle traffic and the volume of water passing down inter-rows make the use of pre-emergent herbicides in the inter-row inappropriate. The barriers to using pre-emergent herbicides in the inter-rows during winter could be cost, small perceived gain, the widely held view that cover crops in winter are advantageous and a lack of district experience applying pre-emergent herbicides over a germinated cover crop.

Although pre-emergent herbicides can be used successfully to control spiny weeds on drying greens, difficulties exist for growers trying to establish grass on a bare or weedy green. Such growers must carefully time the use of both pre- and post-emergent herbicides around the sowing of the grass, and use herbicides selective against broadleaf weeds.

The potential to use either pre- or post-

emergent herbicides as part of a 'Best Option Strategy' for spiny weed seed control in Sunraysia vineyards is limited by the following points:

- (i) Furrow irrigators have difficulty getting good incorporation of undervine herbicides reducing the cost effectiveness of pre-emergent herbicides.
- (ii) A loss of organic matter in a total herbicide vineyard will lead eventually to poor soil structure, loss of soil nutrient retention capacity and greater leaching of pre-emergent chemicals into the water table, where they are wasted and may be hazardous over time.
- (iii) Sandy alkaline soils in the district are associated with a high risk of vine uptake of simazine and other herbicides.
- (iv) Extension staff in the Department of Agriculture and Rural Affairs (DARA) may not give off-label recommendations for chemical use. In the short term at least the range of herbicides DARA staff may recommend for over-spraying cover crops is limited.
- (v) Weed resistance continues to evolve and so we must not increase our reliance on herbicides.
- (vi) Many growers accept the false economies of belated weed control, suggesting that they place small importance on the concept of total weed management and are ignorant regarding weed biology and herbicide action.

Irrigation

Furrow irrigation is used in 80% of Sunraysia dried fruit producing vineyards. The remaining growers use sprinklers (19%) and drip irrigation (<1%). All growers within the Mildura, Red Cliffs, Robinvale or Merbein irrigation districts must order water from the Rural Water Commission or from the First Mildura Irrigation Trust and most order it every 10 to 21 days, depending on the season. Water costs growers \$37-\$47 per megalitre but it is likely that this price will increase in the near future, making efficient irrigation a greater priority to growers than it currently is.

Irrigation places constraints on the potential to control *Cenchrus* and *Tribulus* in Sunraysia. The use of strategically timed post-emergent herbicide treatments for summer growing weeds, as practiced in many crops, is limited because of continuous *Tribulus* and *Cenchrus* germination throughout summer in the bare, moist inter-rows under furrow and sprinkler irrigation.

A final (post-harvest) irrigation in March encourages early germination of a large proportion of the year's germinating seed reservoir of *Emex*. This can be turned to advantage; if emergence of an early wave of *Emex* can be encouraged, and the seedlings killed without further disturbance to the soil, the proportion of *Emex* which will germinate throughout the rest of the season will be reduced.

Sprinkler and drip irrigation systems have some advantages over furrow irrigation for achieving control of spiny weeds.

- (i) Under drip and sprinkler irrigation systems there is no need for inter-row cultivation during summer. This helps reduce the emergence of *Emex* and *Tribulus* and enables cover-crops to be left to mulch in summer, providing competition to *Tribulus*.
- (ii) Sprinkler irrigation provides moisture necessary for incorporation of residual herbicides on undervine banks. For furrow or drip irrigators, getting adequate rain for incorporation is difficult.
- (iii) Under drip irrigation, it is easy to manage a dry summer mulch from a winter active perennial cover crop. Under sprinkler or furrow irrigation, a cover crop is provided with moisture and may need to be spray-topped or mown to prevent summer growth.

Cover crops and mulches

With good cultural management, mulches and cover crops can play a significant role in suppressing weed growth in Sunraysia vineyards. Self sowing, winter active, mulching crops should not be very difficult to incorporate into local vineyard practice if slashing/mulching is accepted as an alternative to cultivation for frost control.

Emex, *Cenchrus* and particularly *Tribulus* are sensitive to competition with other species and can be suppressed by mulch. Weed suppression using one bale of straw mulch per panel has been demonstrated in vineyards in Sunraysia, although at a cost of about \$800 per hectare, buying straw is not a viable option for growers. Any strategy developed to assist growers to eliminate spiny weed seeds from their vineyards must include increased use of mulches and cover crops, to improve soil structure, moisture retention and soil permeability and so reduce saline accessions into ground water.

Salinity and environmental degradation are two great challenges facing dried fruit growers. But growers do not modify their management to reduce the amount of salt, fertilizers or chemicals entering the Murray River from their irrigation drainage because environmental considerations do not yet provide costly or visible constraints on management. Community action to reduce salt inputs into the river, however, will soon greatly influence vineyard management. Inherent in this will be increased use of cover crops.

Trials are being conducted by the NSW Department of Agriculture and Fisheries, Dareton to investigate cover crop self regeneration and soil improvements resulting from seven clover and medic species sown in April 1989 and developed as a permanent sward in vine inter-rows. After 18 months, the crops have demonstrated good weed suppression, survived over-spraying with post-emergent herbicide (Tribunil) and withstood up to

three mulchings. The last mulching in October, led to total haying-off of the stand. During summer the mulch helped conserve moisture and reduced weed growth to a level that could be well controlled by one spot spraying of glyphosate and one late-summer spot spraying of paraquat. By July 1990, excellent regeneration of some of the trialled species was observed.

Management of these crops involved little more than the standard management of winter cover crops in this district, although extra irrigations were applied to the legume stands, to allow them to grow to their full potential.

Trellising

Vines are typically trained onto a 90 or 120 cm high single wire or T trellis. Use of rootstocks, and more recently mechanization, has led to taller trellising. Higher trellising reduces the risk of frost damage to buds in Spring and so may remove the need to cultivate inter-rows in August. Reduced cultivation corresponds to lower germination rates of *Emex* and *Tribulus*, and allows for establishment of a permanent, competitive cover crop.

Trellis design determines the ease with which a grower can apply touch up applications of pre-emergent herbicides or use regular post-emergent sprays under the vines during summer. Although the canopy may still hang to the ground from a high trellis, 'topping' of cane ends to facilitate application of undervine herbicides is relatively easier than under a low trellis. The flexibility to apply herbicides when necessary will be a great advantage to growers working towards total spiny weed control.

Mechanical harvesting

About ten percent of Sunraysia's dried vine fruit is harvested mechanically. Mechanical harvesting will contribute favourably to a long term spiny weed control strategy. It removes the opportunity to retrieve fruit dropped onto the ground, so removing one source of contamination. Mechanical harvesting also removes the risk that the buckets used for hand harvesting will collect spiny seeds, either while being scraped along the ground (perforated dip tins) or by being punctured underneath and later stacked on top of full buckets (plastic Bryce buckets).

Mechanical harvesting is often associated with taller trellis designs. Growers with tall trellises can consider the preferred long term non-cultivation approach to *Emex* and *Tribulus* control without risking frost damage to buds.

Mechanization alone will not enable growers to produce weed seed free fruit, because it does not remove the need to finish-dry fruit on ground sheets, which is another probable source of contamination. Artificially drying fruit in a dehydrator instead of finish-drying on ground sheets produces a product slightly different to the popular golden sultana, so

finish-drying is likely to continue.

There are barriers to adoption of harvesting and pruning mechanization, including the cost associated with conversion to a suitable trellis design, management of vine vigour, difficulties of drying fruit and a perception that mechanization produces lower fruit quality.

Prickle roller

The Victorian Dried Fruits Board lends growers a 'prickle roller' that greatly aids removal of spiny seeds from drying greens. The two metre wide, carpet covered roller is towed across a drying green and the carpet cover collects surface lying prickles.

The benefits of the roller are measurable by the number of surface-lying spiny seeds it can collect in a single pass across the drying green area. The prickle roller is limited to collecting seed off even ground, and therefore cannot be used in vine rows. There has been some thought given to developing a flexible, water filled, foam padded cylinder mounted to the front of a 4 wheeled motor bike for collecting seeds from between and under the vines.

While passes with a prickle roller should be a regular activity on the drying greens of all dried fruit growers, its use without vigilance and follow-up spot spraying or shovel work will not guarantee a weed seed free drying green.

Vehicles in vineyards

Vehicle movement between and within vineyards contributes to the spread of spiny weed seeds. Restrictions on foreign vehicle access to vineyards must be encouraged.

Integration of cultural practices for development of short and long term weed control strategy options

Short-term Tribulus and Cenchrus control

The following options would assist Sunraysia vine growers gain effective short-term *Tribulus* and *Cenchrus* control:

Inter-row:

- cultivate every four weeks from November to March or
- apply residual herbicides in late October to sprinkler or drip irrigated vineyards or
- apply post emergent herbicide every 4 weeks from late November to March.

Undervine:

- sillyplough in August and follow-up with a pre-emergent herbicide application in September/October or
- apply pre-emergent herbicides to existing undervine banks in September/October or
- spot spray post-emergent herbicides every 4 weeks throughout summer using a shielded sprayer or
- develop an undervine mulch, with occasional spot spraying of escaped weeds.

Drying Green:

- apply pre-emergent herbicide in October to bare ground or spray over a couch sward or
- spot spray post-emergent herbicides regularly at rates not damaging to couch
- use vigilance and a shovel
- use the prickle roller regularly.

Longer-term Tribulus and Cenchrus control

A longer term program for control of summer spiny weeds however should include:

Inter-row:

- sprinkler irrigation
- tall trellis
- shielded spot spraying of post emergent herbicides
- either a deep mulch remaining from a winter grown cover crop or a chemically hayed or slashed winter active perennial cover crop.

Undervine:

- sprinkler irrigation.
- tall trellis
- use pre-emergent herbicides in the mid term.
- use mulches in the long term.
- use vigilance, and shielded spot spraying when necessary.

Drying Green:

- couch sward top-sprayed with post-emergent herbicides if necessary.
- use vigilance and a shovel.

Short-term Emex control

A program for effective short-term *Emex* control could have the following options;

Inter-row:

- cultivate every four weeks from April to November or
- apply post emergent herbicide every four weeks or
- apply pre-emergent herbicide in April.

Undervine:

- knife plough every four weeks or
- silly plough in March/April and apply pre-emergent herbicide or
- apply pre-emergent herbicide to prepared bank.

Drying Green:

- cultivate area to clear weed growth, roll flat, prickle roll and apply residual herbicide (once only, worst case situation only) or
- apply post-emergent herbicides every four weeks or
- apply pre-emergent herbicide in April or
- spot spray regularly over couch sward.
- use vigilance and a shovel.

Longer term *Emex* control

A longer term program for control of *Emex* however should include;

Inter-row:

- establish competitive perennial winter active cover crop and top spray it with post emergent herbicide within four weeks of any flush of weed germination through the crop.

Undervine:

- sprinkler irrigation
- apply pre-emergent herbicides in the mid term or
- throw on mulch from inter-row crop.
- use vigilance and if necessary spot spray herbicide over mulch.

Drying Green:

- use a shovel and vigilance.
- spot spray post-emergent herbicides during months of couch dormancy.

Conclusion

The dried fruit industry would like to be able to provide its growers with recommendations for producing grapes that will be free of spiny weed seeds. It should not be difficult to develop a range of practical recipes for successful, short term weed control. But the long term aim must be to use cultural practices which are not in conflict with a move towards more sustainable production and the considerable changes to vineyard management which may occur with this move.

Cultivation contributes to the continued germination of *Emex* and *Tribulus*, so there is a need to concentrate on removing inter-row cultivation.

Use of herbicides provides many advantages for growers, however the use of post-emergent rather than pre-emergent herbicides is preferred in the long term.

Salinity and land degradation issues will raise the importance of and change attitudes to inter-row soil management. In the future there will be greater interest in the use of permanent crops or mulches inter-row, although such crops must not have high water needs in summer.

To include cover crops into a long term weed control strategy that guarantees spiny weed free vineyards more knowledge is required of competition and mulching effects on *Emex*, *Tribulus* and *Cenchrus*. There is a need for further investigation into competition or inhibition of these weeds by potential perennial or annual cover crop species.

Sprinkler irrigation, tall trellising, permanent inter-row cover, undervine mulching, nil cultivation and strategic timing of knock-down herbicides are favourable to improved weed management.