Weeds can poison crops

Aik Hock Cheam
Weeds can interfere with the growth of a crop simply by competing with the crop for nutrients, moisture and light. But some weeds also release chemicals that inhibit the germination and growth of crop plants; the technical term for this is allelopathy. Aik Cheam outlines the problems caused by two common weeds and then discusses preventative measures.

Allelopathy is an unfamiliar term to many people but its unfamiliarity is not a result of recent discovery; rather, allelopathy is just beginning to be recognised as another important factor limiting productivity in much of the crop and pasture zone of Australia. Recently, numerous researchers have identified allelopathic effects as integral components of the present agricultural systems.

Allelopathy has helped to explain the common failures and disappointments in establishment and growth of crops and pastures. There is also hope that allelopathy can one day be exploited by allowing a crop to inhibit the growth of weeds, just as weeds are now inhibiting crops. Some of this is probably already occurring.

This article illustrates two examples of allelopathy that have been the subject of investigation by Agriculture Western Australia in recent years. The examples will demonstrate the importance of allelopathy and the need to keep an open mind each time there is a crop establishment failure.

**Goosefoot allelopathy**

Goosefoot is a major summer weed in the Western Australian wheatbelt, especially following adequate spring and summer rainfalls. It is a widespread weed of southern Australia and is a native plant. Many farmers in Western Australia call it mintweed, its botanical name is *Chenopodium pumilio*.

There are two distinct forms of goosefoot; the erect form is more common and widespread than the prostrate form. Both forms can inhibit crop and pasture establishment by releasing toxins into the soil. The toxins inhibit seed germination and seedling growth, causing total inhibition of germination at high concentrations.

So far, four toxins have been identified in goosefoot residue. The toxic effects are more severe when the compounds occur in combinations rather than as single substances.

Other problems caused by goosefoot include the removal of stored summer moisture in the soil as well as acting as a host for Rutherglen bugs which can later attack emerging crops, especially lupins.

**Toxicity management**

Management strategies have been developed to prevent or reduce the damaging effects of goosefoot allelopathy on crops and pastures.

*Early control*

Early control of goosefoot should be the first priority as it takes only about four weeks for the seedlings to start producing seeds. Seedlings that emerge in spring and summer should be targeted for early control rather than being allowed
to mature until seeding of crops or emergence of pastures. Mature goosefoot plants contain more toxin than younger plants; in fact there is a direct relationship between the weight of the plant and the amount of toxin it contains. Most of the toxins are found in the stems and leaves.

Although goosefoot can germinate after autumn rains, the seedlings generally grow slowly and are often suppressed by other more vigorous plants, for example, capeweed, that germinate at this time of the year.

Despite the benefits of controlling summer weeds many farmers tend to put off spraying because they feel it is a waste of money to control weeds that are not associated with crops. The small and harmless appearance of goosefoot in their early growth stages, also contributes to decisions not to control the weed. This inaction can cause significant crop and pasture losses associated with the allelopathic activity if the goosefoot plants are allowed to grow until the time of crop sowing.

Control of the mature plants is generally not too late provided there is sufficient time for the breakdown of the plant remains and for the toxins to be leached from the seed zone by the autumn and winter rains.

Plants killed at least two to three months before sowing are therefore more likely to receive enough rain to allow breakdown and leaching of toxins. This early control also allows the use of non-selective herbicides before the emergence of useful plants such as pasture legumes.

There are several herbicide options that work well on goosefoot (see table). Spraying in the cool of the day will generally improve the control and the addition of 1 to 2 per cent crop oil is beneficial during summer. Combinations with atrazine have also given good results in commercial trials, but in experiments conducted over the last few seasons by John Peirce of Agriculture Western Australia, the results have not been consistent. Chlorosulfuron also has activity when tank-mixed with products such as Spray.Seed® and 2,4-D.

<table>
<thead>
<tr>
<th>Herbicide</th>
<th>Small seedlings</th>
<th>Mature plants</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,4-D ester</td>
<td>400 mL</td>
<td>800 mL</td>
</tr>
<tr>
<td>Spray.Seed® + 2,4-D ester</td>
<td>750 mL + 300 mL</td>
<td>1500 mL + 400 mL</td>
</tr>
<tr>
<td>Ally® + 2,4-D ester</td>
<td>3 g + 300 mL</td>
<td>5 g + 500 mL</td>
</tr>
<tr>
<td>Ally® + glyphosate</td>
<td>3 g + 350 mL</td>
<td>5 g + 500 mL</td>
</tr>
<tr>
<td>Ally® + 2,4-D amine</td>
<td>3 g + 500 mL</td>
<td>5 g + 1000 mL</td>
</tr>
</tbody>
</table>

**Herbicides for goosefoot control based on trials carried out by AgricultureWA**

(data from J. R. Peirce)
Delayed seeding

Because rainfall is needed to leach the toxins, dry summers and autumns with a late season break provide the greatest risk of toxicity to germinating crops and pastures. However, if there is a good opening rain, as experienced in most parts of the wheatbelt this year, a delay in sowing can help to overcome the toxicity problem.

In field trials this year, we have demonstrated that when crops and pastures were seeded immediately into the goosefoot residues at the break of the season, there was considerable damage to their establishment. A delay in sowing of only one week resulted in the establishment of healthy wheat and lupin crops.

The more sensitive canola and legume pastures required at least two weeks delay to obtain a decent crop (Figure 1). The critical amount of rainfall appeared to be between 50 and 100 millimetres. However, more information is needed before we can advise farmers on the amount of rainfall required to leach the toxins from known amounts of goosefoot residues.

Figure 1. Effects of time of sowing on the emergence of (a) wheat, (b) lupins, (c) canola and (d) pasture in goosefoot residues.
Grazing
Although there have been reports of livestock poisoning after grazing goosefoot, many farmers have claimed no ill effects of goosefoot on sheep or cattle. We have noted that thorough grazing of goosefoot paddocks weeks before sowing resulted in an immediate germination of crops and pastures. This is in contrast to the delay in germination where goosefoot has been present at sowing time.

Crop tolerance
Where goosefoot is a problem, avoid sowing canola. It is the least tolerant crop species. Wheat is generally more tolerant than lupins, especially on sandy soils.

In all crops, the amount of allelopathic injury may increase with the depth of seeding. This could be because the deeper planting increases the length of the shoot/hypocotyl below the ground, thus providing a greater target area for the toxins.

Although there are varietal differences in tolerance within each crop, no variety has been found, so far, to have extreme tolerance.

Other comments
Overall, the results of our research on goosefoot allelopathy have provided explanations for the following:

- Why the control of small goosefoot seedlings is important, as the amount of allelopathic material is minimised long before crop and pasture establishment.
- Why the timing of goosefoot control is important, so as to allow decomposition of residues to occur before sowing.

Wild radish allelopathy
Wild radish (*Raphanus raphanistrum*) not only competes with crops, it also interferes with harvesting, and its seed and pod material often contaminate harvested grains, both cereals and legumes. Separation of the pod segments from the wheat grains can be difficult because of their similarity in size and weight.

In both wheat and lupins the contamination problem is quite common, especially in years with late rains when wild radish continues to grow and remains green after crop maturity. With the recent confirmation of herbicide resistance in wild radish, the contamination problem may increase if the resistant populations get out of hand.

This contamination is especially damaging to crop seeds in grain silos because the green wild radish pod gives off substances that actually kill the stored seeds. The family Brassicaceae, to which wild radish belongs, is notorious for the number of volatile toxic substances it produces, especially allyl isothiocyanate, derived from the glucosinolate sinigrin which is mainly found in the fruits and seeds of wild radish.

Crops and pastures failed to establish when seeded immediately into the goosefoot residues at the break of the season.

The toxins inhibit germination and metabolism; the affected seeds generally die and those that emerge will have abnormal roots and shoots. Therefore, if green wild radish is found growing in crops at or near harvest time, avoid harvesting from areas where wild radish is still green if the crop is to be saved for next year's seed.

Crop sensitivity
Some research has been done into the sensitivity of lupins, field peas, wheat and barley to the radish toxins. All four crops were found to be sensitive, and the degree of sensitivity depended upon the storage temperature, the level of radish contamination, the storage period and the crop species or cultivar involved.

The higher the contamination level and the longer the storage period, the greater is the damage to the crop seed if storage temperatures are high, around 40°C (Figure 2). Such temperatures are common under summer field conditions in the wheatbelt.

In one experiment, damage to the lupin seed began at the 5 per cent level of contamination (weight by weight) and a storage period of three days. All the lupin seed was killed at the 8 per cent contamination level over a five day period. Total kill was also noted over a three day period at a contamination level of 9 per cent or more.

Danja, Gungurru and Yorrel lupins were equally sensitive at the 10 per cent contamination level resulting in total kill over a storage period of one week.

Field peas such as Pennant, Dundale and Wirrega, although slightly less sensitive than lupins, still showed a 98 to 99 per cent loss of germination when contaminated with 10 per cent radish for one week.
Within the wheat varieties tested, all the seeds of Cadoux were killed at a 5 per cent contamination level over a one week storage, in contrast to 61 per cent kill in Gutha and 41 per cent in Spear wheat.

All the seeds of Yagan barley were killed at the 5 per cent contamination level, in contrast to a 75 per cent kill in Franklin and 70 per cent in Stirling barley.

The important message is not to store crop seeds containing green radish pods for next year's seed supply. Because of the wide-spectrum action of the toxins, early in-crop control of wild radish is essential to reduce contamination of crop seeds at harvest.

Reducing contamination and damage
Several actions are worth considering if green wild radish is found growing in crops at or near harvest time.

- Avoid harvesting seed from areas of the paddock infested with green wild radish.
- The lupin crop can be swathed to allow the wild radish to dry out in the windrow.
- Green wild radish can be 'burnt off' with a desiccant. Reglone® is the only product currently registered in Western Australia for application just before harvest and is registered for use in lupin but not cereal crops. This can only be done when the lupin seed is mature and has a moisture content of less than 40 per cent. Reglone® at 1 litre per hectare with 0.1 per cent wetting agent and 2 per cent oil applied by aircraft with a water volume of 10 to 15 litres per hectare has given satisfactory control at an approximate cost of $17 per hectare.

SpraySeed® and 2,4-D, two other chemical options, are not registered for use on either cereal or lupins in Western Australia. However, 2,4-D ester 80 per cent is registered in New South Wales and Victoria at rates up to 1.4 litres per hectare.
- Seed should be graded within hours of harvesting to remove any green wild radish.

Acknowledgements
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Further reading
- Bulletin 4323 'Cereal, pulse and oilseed weed spraying charts - 1996 (Agdex 102/64).

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