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Skeleton weed: the current situation

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Skeleton weed
the current situation

Skeleton weed is a major threat to Western Australia’s grain industry. This weed established itself throughout the entire eastern States wheatbelt in just over 50 years and is now found from south-east Queensland to South Australia. It was first found in Western Australia at Ballidu in 1963, and since that time has been the subject of an ongoing and intensive eradication campaign. Peter Scott and Jon Dodd report on the present status of skeleton weed in Western Australia and outline the progress to date and future directions of the eradication campaign.

“Skeleton weed is, to us, a horrendous problem. We have been testing different herbicides, tank mixes and tillage practices for a number of years and we don’t really think we are getting anywhere.

“I would like to have Western Australian farmers understand that wherever they can grow lupins, skeleton weed thrives and they should be doing everything within their power to keep it out of Western Australia.” Wayne Haywood, South Australian farmer

The plant
Skeleton weed (Chondrilla juncea) is a perennial plant that originated in the Mediterranean region. It has become a serious weed in Australia following its introduction to the eastern States around 1910. It releases very large numbers of wind dispersed seeds and can also spread vegetatively, from root fragments. Vegetative reproduction is responsible for the rapid localised spread of the plant in cropping areas.

The cost to industry
Why skeleton weed is a problem
Several features of skeleton weed contribute to its status as a major weed of cropping.
- It rapidly increases in density in cropping paddocks as a result of vegetative growth from root fragments formed during cultivation. Early attempts to use cultivation to control this weed actually caused it to increase massively.
- Skeleton weed can reduce soil nitrogen by the equivalent of 56 kilograms per hectare of artificial nitrogen; 33 kilograms per hectare can be tied up in the tops alone. When growing within a crop, skeleton weed competes for nitrogen throughout the life of the crop. It also depletes soil nutrient levels during the pasture phase.
- Competition for soil moisture by skeleton weed reduces cereal yield, especially if this occurs late in the life of the crop when the grain is filling and the crop has a high moisture demand.

In heavily infested cereal crops, yield losses as high as 50 per cent have been recorded in wet years, when water was not limiting, but up to 80 per cent in dry years.
- The tough, wiry flowering shoots that skeleton weed produces in early summer may become entangled in the moving parts of the harvester, preventing harvesting in extreme cases. In lighter infestations, the stems add to machinery wear and tear and may cause harvesting delays.
- There are currently no effective, in-crop control methods that do not either damage existing and follow-up pulse crops, or pasture legumes.

The chemical 2,4-D amine (50 per cent) at a rate of 1.7 litres per hectare can be used to suppress skeleton weed in cereals, to inhibit the plant’s development and prevent problems when harvesting. However, this has no
of the reduced competition from the narrow-leaved form, the other two forms have moved in and taken its place.

In Western Australia, the rust and gall midge were released experimentally at Badgingarra Research Station in the mid 1980s, but neither agent persisted. The presence of the broad-leaved form of skeleton weed in the Narembeen and Yilgarn Shires, where it is causing major problems, means that the existing suite of agents cannot contribute to biological control in this region.

As long as Agriculture Western Australia’s present policy on skeleton weed is one of eradication rather than control, there is no role for biological control in this State. However, the value of reducing skeleton weed populations in the eastern States by biological control is recognised, because this will reduce the risk of new introductions of seed into Western Australia. The CSIRO is continuing to look for biological control agents for the other forms of skeleton weed.

The effect on plant numbers and will not reduce the problem in following years.

An estimated $8.00 to $16.00 per hectare could be required to control skeleton weed in cereal crops (using Lontrel® at 500 millilitres per hectare) to a sufficient degree that would allow the inclusion of lupins in the cropping rotation. This is taking into account that Lontrel® will control some of the other broad-leaved weeds present. However, Lontrel® residues may affect the lupin crop in the year following the herbicide treatment.

Biological control

Biological control agents for skeleton weed include a rust fungus, a gall mite and a gall midge. The rust fungus has significantly reduced skeleton weed infestations in south-eastern Australia, but is only effective against the narrow-leaved form (originally the most widespread and troublesome form). As a result

In Western Australia, the cost of the skeleton weed eradication program, which totalled $1,394,000 in 1995-96, is the cost of ensuring that this weed does not become widely established and uncontrollable.
Each flower head produces up to 12 seeds.

**The eradication program**

The nine infestations that were found in Western Australia between 1963 and 1973 were all dealt with individually. However, following the discovery of several large infestations in the Narembeen area in 1973/74, the Skeleton Weed Eradication Act 1974 was proclaimed at the request of farmer organisations.

This initial Act was to last for three years, but it has been extended seven times with changes to how the levy is rated, the amount of funds raised, conditions for compensation, and the review period extended to five years. Also, a small portion of this fund is now set aside for insecticide resistant grain insect control (up to $20,000 in any one year).

Infestations of skeleton weed have been found in most parts of the South-West Land Division of Western Australia but the total area currently infested is still only

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*Figure 1. Dates when skeleton weed was first recorded in shires in the agricultural regions of Western Australia.*

*Figure 2. Locations of some of the individual farms where skeleton weed has been found – note the concentration in the eastern central wheatbelt.*
around 719 hectares on about 298 properties. All these infestations have been treated and Western Australian farmers are still not suffering production losses as a result of skeleton weed. About half of all treated infestations have been eradicated and 176 farms released from quarantine.

How skeleton weed is eradicated
When skeleton weed is found on a farm and reported to Agriculture Western Australia, the farm is immediately quarantined, the infestation pegged, and the area/paddock searched for further plants. The problem area (including a 20 metre buffer zone) is treated with high rates of Tordon 75® (7 litres/hectare) to destroy the plants. The paddock is then cropped (if possible) for the next three years and during that time the area will be searched by volunteer groups. If no more plants are found for three successive years, the skeleton weed is assumed to be eradicated and the property is removed from quarantine.

Organised searches for skeleton weed are mostly made on properties with known infestations. Farmers and header drivers are asked to keep an eye out for new infestations and notify Agriculture Western Australia. The optimum time for searching is after the paddock has been harvested and before any viable seed has been set. This coincides with the months of November and December in Western Australia.

Stock must not be put into the stubble before the paddock is searched, otherwise the plants could be grazed and made difficult to see. Other methods of searching (e.g. remote sensing) have been used experimentally but so far have not been as successful as the current procedure.

An ongoing problem is that of getting enough volunteer searchers at harvest time from within the local farming community, and in finding all the plants in the first year of searching. This has become especially difficult in recent years because there are now few skeleton weed-free wheatbelt shires that can send volunteers to help search farms in infested shires. In some cases, new infestations are fully established and have been producing seeds for several years before being found.

Searching for skeleton weed
The physical searching of paddocks is possibly still the only practical way to find skeleton weed plants. The cost of this program is one day/season from each farmer (at the most), and $0.12/tonne of grain delivered for sale.

In the Perth Metropolitan area, 1371 plants were found in 1994/95, with infestations occurring in three new areas. The east-west railway lines yielded a further 176 plants between Perth and Kalgoorlie.

The re-infestation of existing quarantined paddocks is one of the main problem areas for the eradication program. In 1995/96, 99 farms became re-infested with skeleton weed, increasing the infested area by 312 hectares.

But only 24 of these paddocks had 100 or more plants (47.34 hectares) in the infestation, indicating that most infestations are relatively small.

History of skeleton weed in Western Australia
The earliest infestations of skeleton weed were widely separated from each other, in the Wongan-Ballidu, Esperance and Greenough Shires. This suggests that they were separate, independent introductions.

The skeleton weed eradication program began in 1973/74 following the discovery of large areas of the weed in Narembeen shire. Since then there has been a trend in the number of new finds of skeleton weed on farms each year. There seem to be three stages:

STAGE 1 1977-1981, average = 8 new farms per year

STAGE 2 1982-1991, average = 23 new farms per year

STAGE 3 1992 to present, average = 63 new farms per year

In 20 years there has been an 8-fold increase in the average number of farms found to have skeleton weed, from 8 to 63 per year. The 1995/96 search season yielded a bumper harvest of new skeleton weed finds – a total of 99. This is the highest tally on record, and it took the cumulative total of farms in Western Australia that have ever had skeleton weed to 592.

Over the same period, eradications have kept pace with the new finds. About 50 per cent of skeleton weed

Paddock searching is essential to the eradication process.
infested properties have been released from quarantine as a result of successful eradication measures carried out over a three year cropping period.

The spread of skeleton weed in Western Australia
Mapping the dates when each shire was first found to have a farm with a skeleton weed infestation reveals the weed's pattern of spread (Figure 1). Of course, these maps are an exaggeration, because a single infested farm can cause a whole shire to be shaded in (Figure 2), but they reveal a pattern of spread that has not been shown before.

The first known infested shire was Wongan-Ballidu (1963). Over the next 10 years, it was joined by Greenough, Esperance, Dalwallinu and Dandaragan. The scattered nature of these early finds suggests that they were independent introductions.

By 1973/74, skeleton weed had been found in six shires, but 10 years later a total of 17 shires were affected. The number of shires currently affected by skeleton weed has more than doubled since 1983/84.

The pattern that emerges is one of coalescence of infested Shires. This strongly suggests that older patches of skeleton weed are infesting neighbouring shires, before the source populations are found and eradicated. It is now possible to travel from Northampton to Esperance and always be in a Shire that has, or has had, skeleton weed.

What are the implications of this pattern of spread? Can we predict where this weed will appear next?
- It is increasingly difficult to find volunteers to take part in paddock searches, because there are few 'clean' shires left that can send searchers to neighbouring infested shires.
- The Central and Lower Great Southern regions are apparently free of skeleton weed. However, earlier studies showed that these regions are climatically suitable for this weed, so it may just be a matter of time before it invades crops in those areas (Figure 3).
- Shires and regions where skeleton weed has not yet been found should be considered as vulnerable to invasion by the weed. An increased awareness of the risks posed by skeleton weed is needed in those areas where it has - so far - not been recorded, especially those surrounded by affected shires.

The new threat from skeleton weed
Historically, skeleton weed has been viewed as a serious weed of cereals, especially wheat, but it is now recognised as an increasingly significant weed in lupins and other pulses in Western Australia – 55 per cent of the new infestations reported in 1994/95 were in lupin crops.

Several factors point to skeleton weed being potentially a major weed of lupins and other pulse crops:
- lupins are grown in sandy soils that are also most suitable for this weed;
- the area sown to lupins in Western Australia has increased substantially in recent years and now totals around a million hectares;
- many of the herbicides that are used to control broad-leaved weeds in lupins are unlikely to affect skeleton weed;
- no existing herbicides could control skeleton weed in lupins without killing the crop;
- the herbicide residues left after eradication treatment are lethal to the following year's lupins and other pulse crops;
- lupin and pulse crops are grown in rotation with wheat in a continuous cropping system. This means annual cultivation and, consequently, more opportunity for vegetative increase of skeleton weed.

Because of these factors, skeleton weed is now recognised as a major threat to the pulse industry in Western Australia.

Findings from Western Australian research into skeleton weed
Skeleton weed has been the subject of much research in Western Australia since 1980. The three main questions that have been investigated are:

a) How great a threat to Western Australia is skeleton weed?

b) What is the best chemical for skeleton weed eradication?

c) What aspects of the weed's ecology affect its management?
The results of the many different studies have shown:

- Skeleton weed is a major threat to cereal and lupin cropping in Western Australia. It would be as serious here as it is in the eastern States.
- Large areas of the agricultural regions – and beyond – are climatically suitable for skeleton weed. However, not all soil types are equally at risk - duplex soils may be less suitable than 'light' sandy soils for the growth of skeleton weed.
- Two forms of the weed are found in this State - the narrow-leaved and broad-leaved forms. A third form (intermediate-leaved) is known from other parts of Australia but has not been recorded here. Only the narrow-leaved form has been found in the northern wheatbelt.
- Tordon 75D® is the most effective herbicide for eradicating skeleton weed. Research into alternative herbicides is continuing.
- Seed production is not limited by lack of summer rainfall. Even in the absence of summer rain, skeleton weed produces large numbers of highly viable seeds. Recharge of the soil profile by winter rains is the factor controlling seed production.
- Skeleton weed can produce seeds for several months over summer. However, very few seeds would survive a typical summer, because most parts of the wheatbelt receive an average of two falls of summer rain heavy enough to cause mass germination. Subsequent drought would then cause extensive seedling death.
- Most skeleton weed seed loses viability in the field within 12 months. However, a very small proportion of the seeds of the broad-leaved form can survive more than 12 months burial.

Research project in South Australia

A contract was signed in 1995 with Agricultural Resource Management Services (ARMS) in South Australia, to conduct research into developing a total crop management package that will be economically viable for farmers to use in paddocks infested with skeleton weed.

South Australia was chosen for these studies because it provided heavy skeleton weed infestations growing under climatic conditions similar to those in the Western Australian wheatbelt. Although most agricultural soils in South Australia are more alkaline than those in this State, the area around Lamaroo has acidic soils very similar to those in Western Australia and a climate that closely matches that of Western Australia's Lake Varley area. Also, the farmers in Lamaroo are currently struggling to grow lupins in paddocks heavily infested with skeleton weed.

These trials will run for several years. They follow several different rotations of cereals and pulses, with the use of various herbicides for the in-crop control of skeleton weed. The impact of these herbicides on the growth of existing and subsequent crops will be monitored closely. The trials will also study the competitive interaction between skeleton weed and a range of cereal and broad-leaved crops, such as lentils and chick-peas, many of which are recognised as crops of the future in Western Australia. The results of these studies will show just how much of a threat skeleton weed will be to these emerging crops. They will also indicate what control strategies - if any - are compatible with growing these crops in the presence of this weed.

Other benefits from this research will be a better understanding of how skeleton weed will affect lupin production and whether or not long-term management practices (chemical and cultural) will exhaust an established skeleton infestation, leading to a significant reduction in plant numbers.

Conclusion

Without the high level of input into tackling this weed, skeleton weed would now be very widespread and abundant in this State, causing considerable economic damage. Research is continuing into this weed, to ensure that it is understood fully and managed most effectively.

Further reading
