Lucerne Seed Industry Biosecurity Code of Practice for Golden Dodder

CURRENT VERSION

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LUCERNE AUSTRALIA

Government of South Australia

Australian Government

Department of Agriculture and Water Resources

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Foreword

In 2016, the Government of South Australia received funding through the Australian Government's Agricultural Competitiveness White Paper to assist in the development and implementation of a national Lucerne Seed Industry Biosecurity Code of Practice (COP) for golden dodder (*Cuscuta campestris*).

Lucerne Australia has partnered with Primary Industries and Regions SA and the Department of Environment, Water and Natural Resources to develop this national COP, which focuses on the management and prevention of golden dodder, a serious pest weed due to its impacts on lucerne (*Medicago sativa*) seed production.

Golden dodder is a parasitic plant which reduces crop yield and can kill its host plant. Seed contamination with golden dodder can affect domestic and export markets. It can reduce yield and increase the cost of cleaning, which can make lucerne seed production uneconomic.

PCR Test for Golden Dodder

In 2012 a test was developed to detect golden dodder DNA using quantitative polymerase chain reaction (PCR). The test works by amplifying small fragments of DNA specific to a target organism (in this case golden dodder). This PCR test can detect small amounts of DNA from golden dodder in large lots of lucerne seed. Since 2013, outbreaks have been identified using this world-first test, following an industry-driven campaign.

Purpose of this COP

The biggest risks in the prevention – and management – of golden dodder in lucerne seed crops are:

1. Introduction of golden dodder to production areas through newly imported seed lots.
2. Spread of golden dodder by machinery, in particular harvesting equipment.

This COP addresses these risks by assisting to prevent introduction in stock seed, on-the-ground early detection and a rapid response to prevent spread.

Informed industry sources indicate that in the 2015/16 season 88 per cent of Australia's certified lucerne seed was produced in South Australia, 10 per cent in Victoria, with the remainder grown in New South Wales. These three states have been the focus during the development of this COP.

Fifteen years ago, there were less than four known outbreaks of golden dodder in lucerne seed growing regions of south-east South Australia and Western Victoria. During the 2016 harvest, there were 19 detections – highlighting the importance of a COP to avoid it escalating further.

The lucerne seed industry cannot rule out golden dodder being identified in both dryland and irrigated lucerne areas and cannot ignore a positive PCR test result, regardless of the level of the reading.

Lucerne Australia supports and acknowledges the support of industry in implementing the protocols in this COP.

Bruce Connor
Lucerne Australia Chairman
October 2017

1. Objective of this Document

The Lucerne Seed Industry Biosecurity Code of Practice (COP) has been developed in consultation with the lucerne seed industry and government. It sets out and formalises biosecurity best practice for the lucerne seed industry, specifically for golden dodder (*Cuscuta campestris*).

This COP outlines best practice protocols for the application of the PCR test throughout the lucerne seed production chain and clarifies the communication required within and between industry and government to protect the lucerne seed industry from the impacts of golden dodder.

It also highlights effective management practices for new, or existing outbreaks to minimise spread.

2. Is the Code Compulsory?

Some aspects of this COP are compulsory under state policy and legislation (Section 5). This is an industry-driven COP and has been designed to reduce the risk of introduction and spread of weeds, specifically golden dodder. Therefore, all lucerne seed industry participants have an interest and duty to follow these protocols.

2.1 Roles and Responsibilities

It is recommended that all industry participants review this COP in its entirety. However, some sections are specific to industry participants, as set out in Table 1.

INDUSTRY PARTICIPANT	TASK WITHIN THIS CODE OF PRACTICE	SECTION
Grower, Cleaning Facility, Marketer	Review legislative requirements for relevant jurisdiction to understand	Section 5
Marketer	Review import and sowing seed requirements as set out by DAWR,	Section 6
Grower	Review requirements for growing Lucerne seed to prevent outbreaks	Section 7
Grower and Contractor	Review harvesting requirements for Lucerne seed to minimise risk of	Section 8
Grower and Cleaning Facility	Review requirements to clean seed to minimise contamination be-	Section 9
Grower, Cleaning Facility and Marketer	Review the requirements for PCR testing and result notification	Section 10

Table 1: Roles and Responsibilities for each stakeholder within this Code of Practice

3. Scope

This COP covers the best practice methodology for lucerne seed growers, contractors, cleaners, marketers and pest plant management authorities in Australia to minimise the risks and impacts of golden dodder on lucerne seed production.

This COP is an industry agreed and supported protocol that supports state weed legislation to minimise impacts of golden dodder throughout the lucerne seed production and supply chain.

Due to its focus on golden dodder, this COP is not a comprehensive document covering all aspects of biosecurity for the lucerne seed industry. As with all agricultural industries, a range of weeds, pests and diseases are relevant, of which golden dodder is of special significance. While many of the practices and principles relating to golden dodder in the COP should form part of good biosecurity practice in a wider context, stakeholders should seek further advice and information relating to broader biosecurity issues.

This COP follows the production cycle of lucerne seed and highlights how the PCR test is utilised by all sectors of the industry at each stage to minimise the occurrence and impact of golden dodder.

4. Background

4.1 Lucerne Seed Industry

Lucerne (*Medicago sativa*) is a perennial legume which is used mainly for the production of hay, silage and pasture. It is grown extensively in Australia, as well as many other countries including the USA, Canada, South America, the Middle East, Africa and Europe.

The lucerne seed industry in Australia is currently worth around $95 million per year with exports contributing around $30 million and domestic sales of $8.7 million *(Source: Economic Analysis of the Australian Lucerne Seed Industry, 2008 figures*). The remainder of the value lies in associated inputs and the allied industries (e.g. seed processors, marketers) that are crucial to the lucerne seed value and supply chain.

In Australia, lucerne has been an important pasture species for over 40 years and the industry is made up of 200-300 individual seed growers. Most lucerne seed produced in Australia is certified under OECD (Organisation for Economic Co-operation and Development) or AOSCA (Association of Official Seed Certifying Agencies) protocols.

The environment in Australia ensures that growers are capable of producing low dormancy through to highly winter-active varieties, which has led to global companies approaching Australian lucerne seed producers to multiply seed.

For lucerne seed to be marketed in a timely fashion, it requires cleaning immediately after harvest. Certified seed can only be cleaned by a seed processor who is accredited to handle certified seed.

Approximately 85 per cent of the certified seed produced in Australia is grown under the guidance of Plant Breeders Rights (PBR) rulings. This is where a marketing company owns the marketing rights to a specific variety and growers produce seed under a contract with the marketing company. This seed cannot be sold to any other entities. Typically, imported varieties are grown under contract.

The Australian lucerne seed industry produces in excess of 7,500 tonnes of certified seed per year. Informed industry sources indicate that in the 2015/16 season 88 per cent of Australia's certified lucerne seed was produced in South Australia, 10 per cent in Victoria, with the remainder grown in New South Wales.

4.2 Golden Dodder

Golden dodder is the most serious of six introduced *Cuscuta* species currently in Australia.

Golden dodder is a summer growing annual that parasitises broadleaf plants such as lucerne, vegetables and broadleaf weeds. The stems are fine twining, threadlike, leafless stems: red-pink, yellow, orange or cream. Flowers are 3-4mm long, bell shaped, white, cream or pink and occur in clusters.

It is a prolific seeder that grows rapidly, entwining and smothering host vegetation. Plants can produce up to 16,000 seeds each and seed can remain dormant in the soil for more than 50 years, creating a long-term weed issue once an infestation establishes.

Seeds germinate in the soil from September through to April following warm weather when soil temperatures are in the range of 15-38 degrees. Despite having no true leaves or roots, golden dodder grows rapidly from germination to seed set in as little as three weeks.

Although golden dodder does not generally kill lucerne it will weaken the crop, reduce the stand and may reduce yield in hay and seed production by more than 50 per cent. Its most serious impact is contamination of domestic and export seed.

Managing outbreaks is time-consuming, costly and not always 100 per cent successful. Applying a very hot burn to the infested area to destroy the seed bank is the main method of control currently applied. There are no selective chemical control treatments currently registered for golden dodder in Australia. Early detection is key to prevent it from growing and seeding in valuable crops such as lucerne seed.

Golden dodder is currently distributed in all states and territories in Australia. However, it is not common in the major lucerne seed growing region of south-east South Australia and Western Victoria.

4.3 State Legislation Differences

While this is a national COP, the distribution of lucerne seed production and golden dodder infestations, along with legislative and policy differences, mean that some information is specific to particular jurisdictions.

Jurisdictions in Australia have state legislation to manage plant pests. Golden dodder is a 'declared' or 'noxious' plant in states including South Australia, Victoria and New South Wales. However, its management varies between states due to the current distribution and impacts on industry and the environment. South Australia gives a high priority to the management of golden dodder; the bulk of the lucerne seed industry is located there.

There are market implications for Australian lucerne seed. Large volumes are exported and contamination with golden dodder risks rejection of exported lots and ongoing market access. The impacts of contamination have been documented in six case studies (Appendix C).

4.4 PCR Test Introduction

The PCR test works by amplifying small fragments of DNA, allowing it to detect small amounts of DNA from golden dodder in large lots of lucerne seed. This invaluable tool provides much greater detectability compared to traditional mechanical and visual inspection methods. Results are reported as the amount (in picograms) of golden dodder DNA per gram of sample. Results are presented as a number from 0 to many thousand. In summary:

- A PCR test result of 0 is considered a zero test result – no golden dodder is detected in the sample.
- Any PCR test result greater than 0 is considered a positive test result.

A PCR test result of between 30-100 picograms is roughly equivalent to one golden dodder seed per 100g of an unprocessed sample. All samples with positive results, even those with low readings, can contain golden dodder seed. The PCR test works best detecting golden dodder DNA contained in fine dust, and it is therefore most successful when applied to uncleaned lucerne seed.

This test is a breakthrough in the prevention and management of golden dodder infestations. It provides fast and reliable detection and can be applied throughout the lucerne seed production chain to protect the industry from the impacts of this weed. Sampling has been conducted on lucerne seed entering cleaning sheds in the southeast of South Australia since 2013 and the tests are carried out at Soil Biology and Diagnostics, SARDI Sustainable Systems.

5. Biosecurity Legislation

This section provides a summary of the legislative requirements in jurisdictions that are relevant to lucerne seed growing regions of Australia i.e. South Australia, Victoria and New South Wales. Refer to the links to read the biosecurity legislation for each jurisdiction in their entirety.

5.1 Commonwealth

The Commonwealth Department of Agriculture and Water Resources (DAWR) is responsible for implementing The Biosecurity Act 2015. Chapter 3 of this Act regulates the importation of goods to Australia.

Under the Act, there are rules and regulations for the importation of lucerne into Australia. These can be found under BICON, the Australian Government's Biosecurity import conditions database. It assists to determine what import conditions exist and if an import permit is required.

DAWR's import conditions for lucerne do not have any specific protocols for detecting Cuscuta species. However, imported seed lots greater than 10kg require International Seed Testing Association (www.seedtest.org) testing to verify the seed lot is free from weed contamination. This is a general test for seed contamination, including contamination with seeds of any Cuscuta species. Seed lots less than 10kg are visually examined by a biosecurity officer, using a sieve and hand lens. If contamination is detected, then the seed lot is sampled and tested in accordance with ISTA procedures. Refer to the BICON website for more details.

5.2 South Australia

Golden dodder is declared under the *Natural Resources Management Act*, 2004 throughout the whole of South Australia. The movement or transport of the plant on a public road by itself or as a contaminant, its entry to South Australia, or the sale by itself or as a contaminant are prohibited. Notification to NRM Authorities of infestations is necessary to ensure these are destroyed. Land owners are required to destroy any golden dodder plants growing on their land. NRM authorities are required to destroy plants on road reserves, and may recover costs from the adjoining land owners. Dodders are declared in category 1 under the Act, for the setting of maximum penalties and other purposes. Any permit to allow its movement or sale can only be issued by the Chief Officer pursuant to section 188.

The following sections of the NRM Act apply to golden dodder and all other non-native species of Cuscuta for the whole of the State:

⇒ **175** (1) A person must not bring golden dodder into the State
(2) A person must not transport golden dodder on a public road.

⇒ **177** (1) A person must not sell golden dodder
(2) A person must not sell soil, vehicles, equipment or produce contaminated with dodder

⇒ **180** (1) If the owner of land becomes aware of presence of golden dodder they must notify the NRM Authority
(2) If NRM authority becomes aware of golden dodder in control area they must notify the Chief Officer.
(3) If Chief Officer becomes aware of golden dodder in control area they must notify NRM Authority

⇒ **182** (1) An owner of land must destroy all plants on that land

⇒ **185** NRM Authority may recover certain costs for the destruction or control of dodder on road reserves, from owners of land adjoining road reserves

Interpretation of the legislation allows for road transport of contaminated produce with the knowledge and written approval of an Authorised Officer.

Where necessary, the Chief Officer may also issue a permit for road transport and/or sale of contaminated produce at a specific time to a specific destination. The permit can contain specific conditions about how the produce is to be transported.

Refer to golden dodder declared plant policy in South Australia here.

5.3 Victoria

In Victoria, dodder (Cuscuta species) are listed as noxious under Part 8, Noxious Weeds and Pest Animals, of the Catchment and Land Protection Act 1994. The Act prohibits all noxious plants from being willfully brought or caused to be brought into Victoria, as well as their trade and transport within the jurisdiction. Further provisions of the Act apply to dodder, depending on where it occurs in Victoria, as follows:

- **Regionally prohibited in the Wimmera and West Gippsland Catchments**
  Regionally prohibited weeds are not widely distributed in a region but are capable of spreading further. It is reasonable to expect that they can be eradicated from a region and they must be managed with that goal. Land owners, including public authorities responsible for crown land management must take all reasonable steps to eradicate regionally prohibited weeds on their land.

- **Regionally controlled in the Goulburn Broken, North East, Port Phillip and Western Port Catchments**
  Usually widespread in a region. To prevent their spread, ongoing control measures are required. Land owners have the responsibility to take all reasonable steps to prevent the growth and spread of regionally controlled weeds on their land.

- **Restricted in the Mallee, East Gippsland, North Central, Corangamite and Glenelg Hopkins Catchments**
  Poses an unacceptable risk of spreading and are a serious threat to another State or Territory of Australia. Trade in these weeds and their propagules, either as plants, seeds or contaminants in other materials is prohibited.

Compliance activities and land owner duties in relation to the Victorian *Catchment and Land Protection Act* 1994 are risk-based. Under this approach, in Victoria golden dodder is dealt with on a case by case basis, often involving provision of management advice. Note there is no legislative requirement to report golden dodder in Victoria, although reporting of contaminated seed lots is encouraged and doing so forms part of this COP.

For more detail regarding noxious weed legislation in Victoria, refer to the Victoria *Catchment and Land Protection Act* (1994), which is the main legislation governing the management of invasive plants and animals in Victoria here.

5.4 New South Wales

Significant weed issues in New South Wales are managed using the NSW Biosecurity Act 2015. The Act provides a framework for risk-based decision-making in relation to biosecurity. For weeds, the local control authority is usually local government. Weed risk assessments have been conducted for golden dodder and other Cuscuta species. Dodders are relatively common, associated with rivers, floodplains, and irrigated areas and are generally not considered a serious risk. As such, NSW weed control programs for dodder are largely based on extension.

Refer to the NSW Biosecurity Act here.

Figure 1: Golden dodder on wireweed, south-east SA (2010-11)

Following this Code of Practice

This COP has been developed by industry for industry. Section 6-11 cover the procedures to manage golden dodder as recommended by the lucerne seed industry. They are to be followed by all industry stakeholder groups in order to comply with this COP.

NOTE: Some aspects of this COP are compulsory under state policy and legislation (Section 5). This is an industry-driven COP and has been designed to reduce the risk of introduction and spread of weeds, specifically golden dodder. Therefore, all lucerne seed industry participants have an interest and duty to follow these protocols. Some protocols are taken from existing legislation, whilst others are additional, industry driven protocols.

6. Import and Sowing

Lucerne seed is both imported and exported globally. In Australia, a mix of Australian bred and imported varieties are grown. Contamination of imported basic and pre-basic seed with golden dodder represents one of the major pathways for introduction of dodder into the production chain.

Although not prevalent in lucerne seed growing areas of Australia, golden dodder is widespread in other lucerne seed producing countries, including the United States. All imported lucerne seed from the USA must be treated with Thiram and containerised prior to entry to Australia, as per the *Commonwealth Biosecurity Act* 2015.

The success of the PCR test is attributed to its ability to detect fine dust containing golden dodder DNA, thereby being most successful with uncleaned lucerne seed. Sowing seed imported from the US has been cleaned to remove dust fragments and treated with Thiram, resulting in a lower likelihood of identifying golden dodder in imported seed lots.

To minimise the threat of contamination from imported seed, the following protocols will be followed to comply with this COP:

6.1 Imported Sowing Seed

DAWR's import conditions do not have specific reference to detecting Cuscuta species. However, imported seed lots greater than 10kg require International Seed Testing Association to verify the seed lot is free from weed contamination.

6.1.1 Small lines for domestic multiplication

Lines of seed less than 10kg derived from small plot areas for multiplication pose less risk of contamination. By virtue of the production scale, the production area and seed lines can be screened in the USA stringently prior to importation. To comply with the COP, the following protocols apply to all lucerne seed on arrival into Australia:

- ✓ Visually examined by a DAWR biosecurity officer, using a sieve and hand lens.
- ✓ Sample taken by an Australian ISTA accredited seed laboratory on arrival at a warehouse facility to test for Purity and Germination.

6.1.2 Sowing seed for certified seed production

Basic or pre-basic seed which has been brought into Australia for certified or basic seed production poses a greater risk of contamination. As such, the following protocols apply to all lucerne seed on arrival into Australia to comply with this COP:

- ✓ Purity test is performed by DAWR, as per government import regulations, at port.
- ✓ Sample taken by an Australian ISTA accredited seed laboratory on arrival at a warehouse facility to test for Purity and Germination.
- ✓ All seed will be passed through an indent roller at a cleaning facility, and the material extracted from the indents PCR tested for golden dodder. The aim is to reduce a 25kg seed lot down to a 100g screenings sample for PCR testing.

6.2 Locally Grown Basic and Pre-Basic Seed

As all locally grown basic and pre-basic seed will be cleaned locally it will undergo the same PCR testing rigour as normal certified seed. The contamination risk from these lines is lower as testing uncleaned seed is a far more accurate way of utilising PCR technology. The following protocols apply:

- ✓ All seed will be PCR tested upon delivery to the cleaning facility and will undergo the same screening rigour as a certified seed crop. (See Section 9).

7. Growing Lucerne Seed

Lucerne seed growers will request PCR test results before planting seed. To comply with this COP, growers should also keep a sample of the original seed and records of sowing details for trace back purposes if a positive result is obtained later in the production process. Growers will implement good hygiene practices and thorough record keeping when growing lucerne for seed production as these are the most effective ways to mitigate the risk of spreading golden dodder on a property.

7.1 Identifying Golden Dodder in the Growing Season

A typical golden dodder plant parasitising lucerne will have a distinctive “orange string” and will either form a thick mat on top of the lucerne canopy or drastically affect the health of the lucerne which may create an opening in the canopy – both of which are easily seen in growing and advanced stages. See Figure 1.

Upon discovery of a golden dodder infestation on a property, the grower will initially refer to Section 5 of this COP and review the legislative requirements in the relevant jurisdiction.

In the case of an outbreak in South Australia, the grower must notify the pest plant management authorities immediately, thereby serving two purposes. First, it meets grower statutory responsibility under section 180 of the NRM Act. Second, it allows for expert advice to manage the infestation. A golden dodder management plan will be developed, and key actions will include:

- Isolate area of infestation.
- Destroy all plants.
- Grower to advise contractor(s), cleaning facilities and Plant Breeders Rights (PBR) owners of golden dodder presence prior to seed delivery. PBR owners are required to be informed if the paddock is in certification.
- Extra sampling for PCR testing to identify extent of golden dodder area in paddock (e.g. test each bay).

7.2 Isolating Dodder Infestations

Once golden dodder plants are discovered in the paddock or a positive PCR test is received, protocols will be put into place to minimise spread, and movement through the infested areas avoided as much as possible. To comply with this COP, protocols are:

- ✓ Wash boots at exit to paddock.
- ✓ Check tyres and underside of machinery and vehicles for plant material at paddock exit.
- ✓ Any stock from the paddock should go to a 'clean out' pen devoid of vegetation or to slaughter. In particular:
    - If livestock have grazed paddocks infested with golden dodder, then a quarantine period should be considered. Golden dodder seed excretion is likely to peak 24 hours after ingestion followed by a steady decline to lower levels over a period of one month. As a guide, four-to-seven days quarantine is preferable. However, growers need to balance risk with realistic management measures.
- ✓ Any hay from the paddock to be fed out on cereal based pastures or sent to feedlot.

It is the growers' responsibility to ensure protocols are adhered to by all people entering the paddock.

In the initial stages after discovering an infestation, the whole paddock should be assumed to be infested to most effectively prevent any spread from the paddock.

In South Australia, the pest plant authorities require growers to develop an annual paddock and property management plan. Other jurisdictions will support growers on a case-by-case basis.

7.3 Machinery and Vehicle Hygiene

Ensuring all vehicles that enter lucerne growing areas are clean is the most effective way to prevent spread. Established guidelines for machinery hygiene can be found on the Farm Biosecurity Website. Cleaning required for machinery and vehicles will vary according to their type and the potential level of contamination. Effective options for cleaning of machinery and vehicles are:

- ✓ **Air blast:** Useful for hard-to-reach areas; use a compressor with a hose.
- ✓ **Wash-down:** Apply water at high pressure using a pressure cleaner or spray tank and pump.
- ✓ **Vacuuming:** Can help remove weed seeds from the interior surfaces of machinery.

To comply with this COP, hygiene requirements will be clearly communicated to all employees or contractors prior to harvest, and facilities/ equipment for cleaning provided where necessary.

7.4 Record Keeping

Growers will keep detailed diaries on all activities in lucerne paddocks. Recording who, when, what piece of machinery and in what direction the paddock was harvested for seed will assist in identifying risk areas and managing potential infestations.

If golden dodder is found, to comply with this COP both the grower and – depending on jurisdictional requirements – the local pest plant management authorities, will refer to questions outlined in Table 2.

Recording information relating to these in as much detail as possible will assist in identifying any additional infestations and limit spread to other properties/areas of the property.

Table 2: Trace Back, Trace Forward and Other Paddock Information

TRACE BACK	TRACE FORWARD	OTHER PADDOCK INFORMATION
Where did the seed come from and when?	Where did the harvested seed go from the paddock-cleaner and customer?	What was the route the header took in the paddock last season?
Has there been any new equipment in the paddock and where did it come from?	What were the next locations the harvester went to after this paddock?	What is the route the sprayer follows in the paddock?
Has there been any new stock in the paddock and where and when did they come from?	What were the next locations the sprayer went to after this paddock?	Where was the hay fed out in other paddcks on the property?
Are there any samples of the original seed or seed from last year remaining?	Where did the hay / stock from that paddock go?	Were other seed lots blended with this sample? Were individual samples taken for each paddock?
Have PCR tests been done in the past? Were there positive PCR results for paddocks harvested prior to this?	Can separate PCR tests be undertaken to further isolate the golden dodder location?	Are there any historic, accessible spatial data available to refer to?

8. Harvesting Seed

Harvesting is one of the highest risk activities for spreading golden dodder onto and across a property. Consequently, growers and contractors will follow the following protocols to comply with this COP:

8.1 Scheduling/Preparation

Work in uncontaminated paddocks first. The lowest risk is to start with paddocks with no previous positive PCR tests and move to progressively higher risk paddocks and areas.

Where possible, the best risk management practice is to use a designated, separate header for paddocks with high risk e.g. previous outbreaks. Where this is not possible, careful oversight of the contractor is required.

Harvesting contractors will contact the grower or property manager prior to the start of the harvest season and request:

- ✓ Any precautions for entering the property, including known contaminants.
- ✓ Whether golden dodder plants have been found in any paddocks on the property.
- ✓ PCR test result certificates from previous years' harvests.

8.2 Sample Collection

To comply with this COP, samples will be collected by the machinery operator during harvest, from each paddock. The protocols for these samples include:

- ✓ One sample will be taken from the paddock if the paddock is not suspected to have golden dodder:
  - The header operator will take a sample from inside the header bin.
  - The sample will be placed in a sealable, clear plastic or paper bag.
  - The header operator will mark the bag with date, paddock name and bay number.

- ✓ Samples will be taken from each bay/section of the paddock if the paddock is suspected to have golden dodder:
  - The header operator will take a sample from inside the header bin.
  - The sample will be placed in a sealable, clear plastic or paper bag.
  - The header operator will mark the bag with date, paddock name and bay number.

- ✓ All samples will be clearly labelled and stored in a cool, dry area. Samples may only need to be PCR tested if an unexpected positive result is found.

8.3 Log Books

To comply with this COP, the machinery operator will keep a machinery and vehicle diary for each paddock on the property. This will be a useful document should contamination be found. It should record:

- The date.
- Paddock name.
- Direction of harvest e.g. order of bays.
- Other machines in the paddock.
- Where the machine came from and is going next.
- Zero, or positive, PCR test results confirmed from previous years.

8.4 Machinery Hygiene

8.4.1 Clean down site

After a lucerne seed paddock has been harvested, the machinery operator will:

- ✓ Clean down vehicles and machinery on-site to prevent contaminants being spread.
- ✓ The clean down site will be within paddock boundaries but outside of the production area.
- ✓ Clean down sites will be close to exit/entry points and clear of watercourses and drainage lines.

8.4.2 Header clean down

Using an air compressor for cleaning a header will achieve the best outcomes in a relatively short space of time. When cleaning the machine after harvesting each paddock of lucerne seed, open all panels and covers, start at the top of the machine and blow out all dust and chaff. When clean, repeat the process with the engine cover open to avoid blowing excess dust into the enclosure. This COP also requires the user to:

- ✓ Check the harvester front by inspecting under guarded areas, for build-up of dust and chaff.
- ✓ Check dust and chaff accumulation around hydraulic motors and bearings.
- ✓ Check that exhaust pipes/manifolds/mufflers and turbochargers are free of dust and chaff.

8.5 Disposal of Weed Seeds

Weed seeds, chaff and dust will be destroyed on the cleaning site, by incineration.

9. Cleaning Seed

For lucerne seed to be marketed it requires cleaning after harvest. Certified seed can only be cleaned by a seed processor who is accredited to handle certified seed. Risks during cleaning include cross contamination between different seed lines.

A PCR test will be conducted on arrival at a cleaning shed and prior to cleaning. If a test is zero, it assures the grower and cleaner that the seed is free from golden dodder and safe to clean and market. If the result is positive, it enables the cleaning shed to manage the seed differently to minimise the risk of cross-contamination during cleaning. All cleaning facilities organise the testing of seed, and the cost is paid by the grower (or PBR owner) as part of the overall cleaning fee.

Under this COP, growers must:

- ✓ Advise cleaning facility of any known golden dodder outbreaks in advance.
- ✓ Enter into an agreement with seed cleaning facilities to share PCR test results.
- ✓ Communicate with local pest plant management authorities if a positive result is found.

9.1 Seed Growers

9.1.1 Communication and reporting

As part of this COP, growers must enter into an agreement (Appendix A) with seed cleaning facilities that enables PCR test results to be shared with the relevant jurisdictional authority.

Growers will also advise the seed cleaning facility of any seed harvested from a golden dodder infested, or previously infested areas, so that the cleaning facility can schedule the cleaning to prevent cross contamination of other seed lots.

Where a PCR test returns a positive result before cleaning, the grower will notify the pest plant management authority. Depending on jurisdictional requirements, the pest plant authority may provide advice on biosecurity management of golden dodder. The grower is responsible for following the protocols set out in this COP.

9.2 Seed Producers

9.2.1 Communication and reporting

To comply with the COP, the seed processing facility will:

- ✓ Ensure the grower agreement is in place.
- ✓ Ensure a PCR test is undertaken prior to cleaning seed.
- ✓ Communicate with the grower, pest plant management authority and PBR owner, to advise of the PCR test result (See Section 10).

9.2.2 Sampling Method

At the cleaning facility, persons responsible for sampling will ensure that:

- ✓ These sampling guidelines have been reviewed and understood.
- ✓ Sampling equipment is available.
- ✓ Relevant materials for sampling, including packaging, labels and recording documents are in place.

Under the COP, all incoming loads of lucerne seed to the cleaning facility are to be sampled and PCR tested.

The following protocol has been determined to provide the best sampling method and will be followed by all cleaning facilities.

ACTIVITY	BEST PRACTICE METHODOLOGY
Sampling Interval	Samples are to be taken at 25%, 50% and 75% as the consignment is unloaded and then mixed to form
Sample Size Collected	A total of 400 – 500 grams (+/-100g),
Sampling Tool	Directly into a clear plastic carrier bag or paper cup, without any seed encountering persons undertaking
Sample Size for Testing	A sample of 100g is mailed (Express Post) for PCR testing at the South Australian Research and Development Institute (SARDI), specifically to: **Soil Biology and Diagnostics, SARDI Sustainable Systems, GPO Box 397**
Recording Procedures	Samples will be packaged and labelled using paper bags, plastic bags and barcode labels specifically supplied by SARDI (contact details above) in accordance with their recording procedures. This packaging and labels will be kept in the main office at the cleaning facility. Any additional samples taken must also be
Communicating Results	SARDI communicates the results by email to the cleaning facility, using an Excel spreadsheet or similar

10. Test Result Process

Cleaning shed personnel will inform the grower of the test result.

10.1 Zero Test Result

If the test is zero, (a zero (0) reading), it indicates the sample is not contaminated with golden dodder and can be cleaned with confidence. Confirmation of the zero test result is communicated to the grower, and a certificate is provided upon request (See Appendix B). Cleaning facilities can proceed with confidence that they will not contaminate other lines.

10.2 Positive Test Result

10.2.1 Visual Inspection, notification

All samples producing positive PCR test results, even those with low readings, can contain golden dodder seeds.

Following a first positive PCR test result, a representative from the cleaning facility will:

- ✓ Notify the grower.
- ✓ Notify the local pest plant management authority.
- ✓ Notify the Plant Breeders Rights (PBR) owner, if applicable.
- ✓ Person responsible for sampling physically checks the primary sample for evidence of golden dodder seeds.
- ✓ A second 100g sample from the stored, composite sample is sent to SARDI for testing.

10.2.2 Following a positive PCR test result, all growers will:

- ✓ Notify local pest plant management authorities.
- ✓ Advise relevant persons – both trace forwards and trace backs – i.e. contractors, transport operators, buyers of seed, in order to minimise contamination risk.
- ✓ Work in partnership with the pest plant management authority to minimise risk of spread in subsequent seasons. In South Australia, growers must develop an annual paddock and property management plan. Other jurisdictions will support growers on a case-by-case basis.
- ✓ Even if paddock inspection does not identify golden dodder plants, the grower will monitor the paddock for a minimum of five years.
- ✓ More detailed sampling during subsequent harvests is needed from paddocks following a positive result. See Section 8.2.
- ✓ Avoid mixing seed with other lines and paddocks.

11. Conclusion

The biggest risks in the prevention – and management – of golden dodder in lucerne seed crops are the introduction of golden dodder to production areas through newly imported seed lots and the spread of golden dodder by machinery, in particular harvesting equipment.

Should an outbreak of golden dodder be found in a lucerne seed production area of Australia it can be controlled effectively, provided the protocols set out in this COP are followed.

This COP supports and protects the Australian lucerne seed industry by producing a 'clean' product that meets market requirements.

By all industry participants complying with this COP, the Australian lucerne seed industry is:

- ✓ Formally committing to golden dodder freedom;
- ✓ Providing uniformity around existing procedures; and
- ✓ Creating a template to follow for any future, unforeseen plant or pest issues that may arise.

12. Review

This COP will be reviewed by Lucerne Australia as needed to ensure it continues to meet the requirements of the lucerne seed industry. Personal communication or meetings with industry participants may be requested by Lucerne Australia if revisions are required. Reviews will occur within a maximum of five-year timeline from implementation.

13. Contacts

Peak industry body:

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Pest plant management authority contacts in lucerne seed growing regions:

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VICTORIA (Wimmera-Western) Department of Economic Development, Jobs, Transport and Resources Ararat, Victoria, 3380 Ph: 03 5355 0532	**NEW SOUTH WALES (Southern)** Invasive Plants and Animals Unit Department of Primary Industries Goulburn NSW 2580 Ph: 02 4824 3737

14. Abbreviations

COP	Code of Practice
ISTA	International Seed Testing Association
NRM	Natural Resources Management
PIRSA	Primary Industries and Regions South Australia
PCR	Polymerase Chain Reaction
PBR	Plant Breeders Rights
SE	South East
LA	Lucerne Australia
US	United States

Appendix A. Grower and Processor Agreement

Lucerne Biosecurity Code of Practice: Notification of a Positive PCR Test Result

Under the best practice approach of the Australian Lucerne Seed Industry Biosecurity Code of Practice, the lucerne seed grower ('**The Grower**') and the seed processor ('**The Processor**') voluntarily agree that all uncleaned loads of lucerne seed delivered to a Processor are PCR tested for the presence of golden dodder.

Both parties also agree to:

- ✓ Enter into this agreement.
- ✓ Share the results of a positive PCR test with the relevant authority.
- ✓ Share the results of a positive PCR test with the PBR owner, if applicable.

By signing this form, The Grower agrees that:

- ✓ If positive PCR test results are obtained for any seed lot, The Processor will make contact with the relevant jurisdictional Authority (e.g. local pest plant management authorities) and PBR owner (if applicable) to advise the Authority of the test outcome and the Grower's details.

Duration of agreement: (insert start and end date):_____

GROWER	SEED PROCESSOR
NAME: _____	NAME: _____
SIGNATURE: _____	SIGNATURE: _____
DATE: _____	DATE: _____

The Grower acknowledges that:

The Processor will not be obliged to commence seed cleaning and processing services until they have received a signed copy of this agreement. However, if at the instructions of The Grower, The Processor commences the services prior to receipt of a signed copy of this Agreement, The Grower will be taken to have accepted the terms of this agreement.

Appendix B. PCR Test Result Certificate

PCR TEST RESULT CERTIFICATE

A 'Quantitative polymerase chain reaction' test works by amplifying small fragment of DNA specific to a target organism

[SEED CLEANING FACILTY DETAILS]

CONTACT

Date:

COMMODITY	Lucerne
VARIETY	
PADDOCK ID / NAME	
CERTIFIED / UNCERTIFIED	
SARDI BARCODE ID	
DATE OF TEST RESULT	
TEST RESULT	

Test results greater than 0 are a positive reading

If positive, seed samples will be inspected to confirm the physical presence of noxious weed seeds in the sample by your seed processor. As a precaution, this seed lot will be isolated. It cannot be moved from its current location without written permission of the pest plant management authorities, if relevant in the jurisdiction.

Note:

- *Results have been based on the seed sample provided.*
- *If certified seed and/or PBR seed, a copy of this test will also be sent to the buyer/marketer.*
- *This test was performed by the SA Research and Development Institute (SARDI) molecular diagnostic centre.*
- *This test was developed via Rural Industries Research and Development Corporation (RIRDC) project PRJ-006872.*
- *This test has been approved, recommended and endorsed by the industry Code of Practice.*

Tackling Golden Dodder - A Lucerne Seed Grower Case Study

Grower 1: Based in the Western Districts of Victoria

Background

Golden dodder (*Cuscuta campestris*) is a serious pest for lucerne seed production. It is a parasitic plant, which reduces crop yield and can kill its host plant. Seed contamination can have a harmful impact on the supply chain, reduce yield and increase the cost of cleaning. This contamination can make seed production uneconomical. In 2012, the South Australian Research and Development Institute (SARDI), in conjunction with Lucerne Australia, the peak industry body for the lucerne seed industry, developed a test to detect the presence of golden dodder in lucerne seed. The 'quantitative polymerase chain reaction' (PCR) test works by amplifying a small fragment of DNA. This PCR test can detect small amounts of DNA from golden dodder in large amounts of lucerne seed, even if a golden dodder seed is not found.

The Situation

A grower based in the Western Districts of Victoria became aware of the presence of golden dodder plants on his property after a very high reading from the PCR test, with seed found in 70 tonnes of lucerne seed, which had been delivered to a local cleaning shed.

Paddock inspections thereafter identified the plant growing in a small area under a 70 hectare centre pivot circle. This area was fenced off. In subsequent summers, other golden dodder plants were found in different sections of the same paddock.

The first positive PCR test reading occurred in 2012 and there is no exact understanding of how contamination occurred. However, the belief is that dodder was introduced by contract machinery, rather than contaminated planting seed. The grower believes that it may have been spread by delvers, or even feral animals such as foxes, as golden dodder plants do exist on nearby properties in the region.

What happened next?

Whilst the *South Australian Natural Resources Management (NRM) Act* does not apply to this property located in Victoria, the lucerne seed is cleaned in SA and was subsequently isolated when dodder was detected in the seed and was unable to be moved without permission.

The grower made contact with the local pest plant management personnel in SA, who provided assistance with movement permits for the seed and on-farm management advice using the 'golden dodder management plan', which has been developed in conjunction with industry.

Following the advice in the golden dodder management plan has allowed the paddock to stay in production by ensuring the effective control of golden dodder on this property and therefore meeting the requirements of the Victorian pest plant legislation. The grower feels that the industry management plan and support from local SA-based personnel provides sufficient risk management.

(continued over page)

Quick Facts

- A lucerne seed grower had a positive PCR test reading during the 2012 harvest and golden dodder plants were identified in the paddock.
- The paddock has stayed in production, whilst a golden dodder management plan is followed.
- Contractors visiting the property are informed of the affected paddock in advance.
- Management costs are significant with one application of herbicide across a centre pivot costing $7,420.00.

Interpreting PCR test results

PCR results are reported as the amount (picogram) of golden dodder DNA per gram sample. PCR test results will be presented as a single number and range from 0 to many thousand.

* **A PCR test result of 0 is considered a negative test result – no golden dodder was detected in the sample.**
* **Any PCR test result greater than 0 is considered a positive test result – golden dodder was detected in the sample.**

A DNA result of between 30-100 pg is roughly equivalent to one golden dodder seed per 100g of an unprocessed sample. All positive tests, even those with low results, can contain dodder. All positive PCR test results should be further investigated.

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In the grower's words:

"We were very open about the contamination and told other local growers about it to highlight that it is an issue. We invited growers to visit the paddock to learn how to identify golden dodder in case they are ever affected in the future. This seemed like the right thing to do to increase awareness generally."

Contractors visiting the property are informed of the affected paddock in advance, and are encouraged to do a thorough clean down of their equipment before moving on to the next property.

The grower has constructed a specialised machine that is used to inspect the paddock in summer. This machine has ability for eight persons to sit along it and monitor lucerne closely for signs of dodder plants.

Financial impact

The grower states that there have been four major financial implications from dodder contamination:

1) **Plant and Equipment:** Construction of a paddock monitoring machine for eight persons to do inspections at the height of the season, and a fence erected to manage the affected site.
2) **Chemical Control:** The grower applies Pendimethalin, a herbicide of the dinitroaniline class used in pre-emergence and post-emergence to control weeds such as golden dodder. The cost of applying Pendimethalin – at a rate of between 5-8 litres – is $13.25 per litre. This equates to $66.25 to $106.00 per hectare for the application, and may be applied up to three times in the season, depending on dry matter levels. The total cost for one application can equate to $7,420.00 for an 8-litre application across a 70 hectare centre pivot.
3) **Labour Hours:** Continual monitoring is a significant cost. Monitoring takes almost a full work day, with about nine persons monitoring the site. This may occur three times in the season, equating to 30 work days. In addition, external visitors such as water meter readers or beekeepers are briefed about the affected area which takes time away from the growers existing tasks and normal routine.
4) **Seed Cleaning:** There is a financial impact of additional seed cleaning to remove any dodder seeds from the lucerne. All infected loads are cleaned at the end of the season, thereby delaying payment for seed delivered. According to a seed processor, a grower with dodder contamination will be charged about 40c per kilogram above the standard cleaning costs. This includes the added cost of cleaning down machinery – which takes 24 hours – powder coating for the magnetic roller, monitoring, laboratory sampling and disposal of offal. On a per tonne basis, this will equate to an additional $400.00 per tonne. Growers will also lose more seed due to the additional cleanouts, estimated to be 100kg more per tonne.

There are also some additional basic management issues. For example, the grower cannot put sheep on the paddock unless they will then be sold, to avoid further contamination. In the grower's words:

"Whilst we were shattered when we received a high PCR reading initially, you just have to move on and manage it. No matter how much you stress about it, you can't change it so we do what we can to manage it and avoid spread."

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Other Challenges

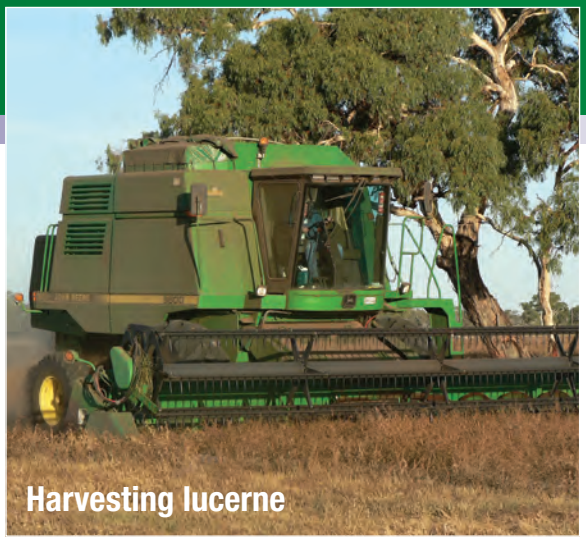
The grower believes that there are three major challenges, that could be overcome with an industry led **Code of Practice** to manage all category 1 weed seeds, including golden dodder:

1) A reduction in contamination through plant and equipment as a result of greater awareness.
2) A reduction in the number of growers being indifferent about the risk.
3) Overcoming different legislative rules to manage golden dodder in different jurisdictions.

The grower applauds industry developing the PCR test to ensure that any new infestations are managed diligently. It also enables growers to monitor paddocks that have very low readings from the PCR test. An industry led Code of Practice will provide agreed rules to assist the industry overcome the different legislative rules within jurisdictions to manage weeds.

Tackling Golden Dodder - A Lucerne Seed Contractor Case Study

Based in South Australia



Harvesting lucerne

Background

Golden dodder (*Cuscuta campestris*) is a serious pest for lucerne seed production. It is a parasitic plant, which reduces crop yield and can kill its host plant. Seed contamination can have a harmful impact on the supply chain, reduce yield and increase the cost of cleaning. This contamination can make seed production uneconomical. In 2012, the South Australian Research and Development Institute (SARDI), in conjunction with Lucerne Australia, the peak industry body for the lucerne seed industry, developed a test to detect the presence of golden dodder in lucerne seed. The 'quantitative polymerase chain reaction' (PCR) test works by amplifying a small fragment of DNA. This PCR test can detect small amounts of DNA from golden dodder in large amounts of lucerne seed, even if a golden dodder seed is not found.

The Situation

A contractor based in the South Australia/Western Victoria region first identified golden dodder about ten years ago. He recalls driving through it with a windrower and not knowing what it was. The windrower was followed by a header. It was the first encounter and once it was understood that it was a noxious weed, there has been greater understanding and more vigilance looking for it.

The grower was unaware of the outbreak until informed by the contractor. The grower was supported by the local pest plant management authority personnel who inspected the paddock and provided a management plan.

The contractor was hesitant to cut the same paddock again, but did so after no plants were identified.

Machinery Hygiene

The contractor focuses on windrowing lucerne and states that windrowers are significantly easier to clean than headers, which have significantly more moving components and are very difficult to clean down 100%.

The contractor maintains that the machines are always cleaned following each property, to minimise spread of all weed seeds. However, a thorough clean down by stripping belts takes significantly longer – eight hours, rather than two hours. This extra clean time cannot be passed to the grower and contractors must bear this cost.

Quick Facts

- A contractor based in the SA/Vic region first identified golden dodder about ten years ago.
- Once it was understood that it was a noxious weed, there has been greater understanding and more vigilance looking for it.
- Machines are always cleaned following each property but a thorough clean down by stripping belts takes significantly longer – eight hours, rather than two hours. This extra time cannot be passed to the grower and contractors bear this cost.
- The PCR test has been a big help as contamination can more easily be identified and allows better prevention and preparedness.

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Government of South Australia

PCR Test

The contractor has harvested four paddocks with golden dodder in the ten years since the first sighting. Three of these four paddocks have found golden dodder as a result of a PCR test result being positive.

Interpreting PCR test results

PCR results are reported as the amount (picogram) of golden dodder DNA per gram sample. PCR test results will be presented as a single number and range from 0 to many thousands.

* **A PCR test result of 0 is considered a negative test result – no golden dodder was detected in the sample.**
* **Any PCR test result greater than 0 is considered a positive test result – golden dodder was detected in the sample.**

A DNA result of between 30-100 pg is roughly equivalent to one golden dodder seed per 100g of an unprocessed sample. All positive tests, even those with low results, indicate dodder may be present and should be further investigated.

Lucerne harvest

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Other Challenges

The contractor has since elected to not take work on properties identified as having golden dodder, as it is felt the risk of spread is too great. There are also some concerns regarding his liability in any contamination case.

In the contractor's words:

"It's definately a liability. I have always been concerned about dragging any weeds around and it worries me with a weed like that - the liability side of getting sued and the thought of taking a weed like that to someone else doesn't sit well with me."

The cost and inconvenience of clean down was also a factor in the decision not to work on dodder paddocks. The financial cost was not large, but the added hours of clean down time were.

The contractor believes that there should be dedicated machines to complete dodder area harvest to mitigate the spread of dodder as the reliability of clean downs is not guaranteed.

The contractor believes that using the PCR test to ascertain if a machine is contaminated would be an option, but the time factor waiting for the results of the test would impact on an ability to move swiftly from property to property. At harvest time, contractors may work on ten or more properties per week.

The contractor has full confidence in the current PCR test process.

In the contractor's words:

"The PCR test is fantastic. I think there were farmers who knew or thought they had it and weren't saying anything. This test has taken the guess work out of it to a large extent. To me, out of everything that has happened, the PCR test is great, so we know what is there. Without that we would have been in real trouble."

Tackling Golden Dodder - A Lucerne Seed Grower Case Study

Grower 2: Based near Keith, South Australia

Background

Golden dodder (*Cuscuta campestris*) is a serious pest for lucerne seed production. It is a parasitic plant, which reduces crop yield and can kill its host plant. Seed contamination can have a harmful impact on the supply chain, reduce yield and increase the cost of cleaning. This contamination can make seed production uneconomical. In 2012, the South Australian Research and Development Institute (SARDI), in conjunction with Lucerne Australia, the peak industry body for the lucerne seed industry, developed a test to detect the presence of golden dodder in lucerne seed. The 'quantitative polymerase chain reaction' (PCR) test works by amplifying a small fragment of DNA. This PCR test can detect small amounts of DNA from golden dodder in large amounts of lucerne seed, even if a golden dodder seed is not found.

The Situation

A grower near Keith in South Australia first detected golden dodder in January 1998. An employee noticed it whilst walking through a 24-hectare paddock. The infestation looked very established and by the size of the patches, it is probable that dodder had been there for at least two or three years. There were two areas, 30 metres wide by 150 metres long and four isolated patches within them. The dodder plants were mostly identified growing along the boom spray track.

It was fortunate for the grower that this paddock was the final one reaped at the end of the season as this minimised risk for further spread to occur on the property.

The grower is still uncertain how the contamination occurred. The grower uses all his own machinery so potential reasons include visitors coming onto the property or the planting seed being contaminated.

In the grower's words:

"Prior to our infestation, my father had travelled to the USA and come back with photos of dodder, saying how terrible it was. When my employee found it, he brought some back to the office. As soon as I saw it, I knew what it was. It was very demoralising at that point, and not to know where it came from was very worrying."

What happened next?

The grower used the Golden Dodder Management Plan, developed in conjunction with pest plant management authority personnel, to manage the infestation.

The grower has found the management plan and the support provided by plant pest personnel a useful resource to minimise further risk. The management plan is still referred to when monitoring the paddock 20 years after the plant was found.

(continued over page)

Quick Facts

- A lucerne seed grower identified large areas of golden dodder in a paddock in 1998.
- High intensity foot inspections and burning were done annually to manage the area over several years before the paddock was taken out of seed production.
- Chairs have been installed on the boom spray to continually monitor the paddock annually.
- The support of pest plant management personnel, along with a management plan, has been a useful resource.

Interpreting PCR test results

PCR results are reported as the amount (picogram) of golden dodder DNA per gram sample. PCR test results will be presented as a single number and range from 0 to many thousand.

* **A PCR test result of 0 is considered a negative test result – no golden dodder was detected in the sample.**
* **Any PCR test result greater than 0 is considered a positive test result – golden dodder was detected in the sample.**

A DNA result of between 30-100 pg is roughly equivalent to one golden dodder seed per 100g of an unprocessed sample. All positive tests, even those with low results, can contain dodder. All positive PCR test results should be further investigated.

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The grower has also installed chairs on the boom spray so that a team can continually monitor the paddock for dodder plants.

Although sheep had grazed that paddock prior to the dodder being found, none has been found on any other part of the property to date. There is continual monitoring due to the longevity of dodder seed, e.g. 60 years.

A Golden Dodder Management Plan, developed in conjunction with pest plant management personnel and industry when dodder was first identified in the south-east region of SA, was utilised to manage the infestation. The grower found this support, along with the management plan, a useful resource to minimise further risk. The management plan is still referred to when monitoring this paddock 20 years after the plant was found.

Financial impact

The financial impact has not been severe for the grower, as alternative commodities have been grown in place of lucerne. Due to the infestation, and also water restrictions, the paddock was taken out of irrigated lucerne seed production.

The grower has not lost any contracts as the seed from the paddock was still able to be sold as certified, although the seed had to be cleaned last, at the end of the season at the cleaning shed. However, there has been a production impact as large areas of the paddock were fenced off. There were also direct intensive management costs associated with continual monitoring to assess dodder regrowth.

There have not been any positive PCR tests from the property since the test was introduced in 2012.

The grower says there will always be a financial impact of taking paddocks out of seed production as a result of a contamination. He is also concerned that there may be impacts on property values from those farms that have had to manage a contaminated paddock.

In the grower's words:

"We use this paddock for dryland and closely monitor it. We have never found any other areas of dodder even though it had been there so long we could have spread it, unknowingly. This is the great thing about the PCR test – I understand it's so accurate that you can be confident that you are clear from a negative test and that's great peace of mind."

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Other Challenges

This grower believes that the biggest threat of golden dodder for the Australian lucerne seed industry is not knowing if it is present on a property. He highlights how remarkable it is that large patches were in his paddock and had gone unnoticed for several years.

He also stated that in order for all growers to manage dodder and be open and transparent about it, an industry **Code of Practice** for golden dodder – and other category 1 weed seeds – is vital. Otherwise, there is far greater risk of contamination through plant and machinery spread.

This grower has great confidence in the PCR test. He is 100 per cent in favour of doing all that is possible to minimise dodder outbreaks and he recommends all growers keep a diary when harvesting.

In the grower's words:

"There is one thing I'd say to others to do – always keep a header diary of where you have reaped. It is not difficult! Just make a note of which bays you reaped in which order, so that if there is a problem down the track such as a noxious weed identified or positive PCR result, you can more easily trace back to the paddock and the bay where it may have been growing.

"In this case, because we had a fertilizer trial in this particular paddock, I had instructed that certain bays be reaped in order, so we could keep a track on any seed that may have been contaminated, if we hadn't done this, we may have missed the plants."

Tackling Golden Dodder - A Lucerne Seed Cleaner Case Study

Based in South Australia

Background

Golden dodder (*Cuscuta campestris*) is a serious pest for lucerne seed production. It is a parasitic plant, which reduces crop yield and can kill its host plant. Seed contamination can have a harmful impact on the supply chain, reduce yield and increase the cost of cleaning. This contamination can make seed production uneconomical. In 2012, the South Australian Research and Development Institute (SARDI), in conjunction with Lucerne Australia, the peak industry body for the lucerne seed industry, developed a test to detect the presence of golden dodder in lucerne seed. The 'quantitative polymerase chain reaction' (PCR) test works by amplifying a small fragment of DNA. This PCR test can detect small amounts of DNA from golden dodder in large amounts of lucerne seed, even if a golden dodder seed is not found.

The Situation

Seed cleaners have adopted a series of protocols for handling lucerne seed which minimises cross contamination and ensures the utmost is done to ascertain whether a positive PCR test is as a result of a dodder seed or other form of contamination.

The process includes:

- Thorough labelling to identify loads.
- Individual grower silos.
- Sampling with no risk of contamination.
- Seed cleaning not undertaken until PCR test is confirmed.
- Drying high moisture seed is done immediately but loads are treated as if they have dodder.
- Close, clear consultation with the grower if there is a positive test.
- Examination by trained staff to physically inspect the loads which have a positive PCR test.

Interpreting PCR test results

PCR results are reported as the amount (picogram) of golden dodder DNA per gram sample. PCR test results will be presented as a single number and range from 0 to many thousand.

* **A PCR test result of 0 is considered a negative test result – no golden dodder was detected in the sample.**
* **Any PCR test result greater than 0 is considered a positive test result – golden dodder was detected in the sample.**

A DNA result of between 30-100 pg is roughly equivalent to one golden dodder seed per 100g of an unprocessed sample. All positive tests, even those with low results, can contain dodder. All positive PCR test results should be further investigated.

Quick Facts

- Seed cleaners have adopted protocols for handling lucerne seed to minimise cross-contamination.
- A grower with dodder contamination will be charged about 40c per kilogram above the standard costs for the additional clean out process.
- If there is a positive result, the sample is inspected closely for a physical dodder seed.
- All growers are informed of all their PCR test results.

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The Process

A sample is taken from all loads of lucerne seed delivered to the cleaning shed. From the sample, 100g is sent to SARDI for testing in a secure bag with traceable bar code.

Cleaning is not undertaken until the PCR test result is returned, except in the case when drying must take place. This is an issue as if moisture is high, it must be dried quickly, and if there is a positive PCR result on a load that has been through the drier, cross contamination could occur.

If there is a positive result, the remainder of the sample is inspected closely for a physical dodder seed. This process may take 2-3 hours for a 750g sample. Growers are informed of all their test results.

The cost of the PCR test is $130, and $35 for each sample.

In the words of the seed cleaner:

"We rely heavily on the PCR tests. The samples and subsequent results are recorded in our system. All "known" outbreaks and new infestations must be cleaned last in the season."

Costs to the grower

A grower with dodder contamination will be charged about 40c per kilogram above the standard cleaning costs. This includes the added cost of cleaning down machinery – which takes 24 hours – powder coating for the magnetic roller, monitoring, laboratory sampling and disposal of offal. On a per tonne basis, this will equate to an additional $400.00 per tonne.

Growers also lose more seed due to the additional cleanouts, estimated to be 100kg more per tonne.

Contacts

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NEW SOUTH WALES (Southern)
Invasive Plants and Animals Unit
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Goulburn NSW 2580
Phone: 02 4824 3737

Other Challenges

- A sealed truck is used to take away the contaminated offal. This is organised though local authorities to a deep burial site. A permit for moving contaminated offal is required. A local pest plant management representative will oversee the load and despatch at the cleaning shed.
- Contaminated lines must be isolated and this also holds up silos.
- More specialist training is required to manage dodder seed identification and this can sometimes take years to educate.
- There have been some very low readings that resulted in no dodder seeds being identified in the sample. All results above zero (0) are taken seriously, to avoid potential contamination.
- Golden dodder is a notifiable weed in all regions of South Australia so growers must inform the local pest plant management authority if there is a positive test. It is important that growers are aware of this legal requirement and that they understand that they are there to assist them with a management plan if a dodder plant is found. The paddock can stay in production, it will just cost the grower more to manage the paddock and the cleaning process.

In the words of the Seed Cleaner:

"Growers like receiving the test certificate to tell them their result is negative. They seem to be more interested in knowing they do not have dodder than any privacy concerns over sharing information".

"It is clear that there are two main sources of contamination, plant and machinery spread and contaminated planting seed. These areas need continual focus as part of an industry Code of Practice to manage category 1 weeds such as golden dodder."

Tackling Golden Dodder - A Lucerne Seed Grower Case Study

Grower 3: Based near Naracoorte, South Australia

Background

Golden dodder (*Cuscuta campestris*) is a serious pest for lucerne seed production. It is a parasitic plant, which reduces crop yield and can kill its host plant. Seed contamination can have a harmful impact on the supply chain, reduce yield and increase the cost of cleaning. This contamination can make seed production uneconomical. In 2012, the South Australian Research and Development Institute (SARDI), in conjunction with Lucerne Australia, the peak industry body for the lucerne seed industry, developed a test to detect the presence of golden dodder in lucerne seed. The 'quantitative polymerase chain reaction' (PCR) test works by amplifying a small fragment of DNA. This PCR test can detect small amounts of DNA from golden dodder in large amounts of lucerne seed, even if a golden dodder seed is not found.

The Situation

Golden dodder was detected via two, high PCR test readings in a seed lot from a grower near Naracoorte in South Australia in March 2016. The first reading from a 9-hectare paddock read 1936, and a second reading in a 43-hectare paddock read 637. The property had no previous history of golden dodder.

The grower was informed of the readings by his local seed cleaning processor, and he immediately contacted the local pest plant management authority to seek guidance about next steps.

What happened next?

The grower took both paddocks out of production and is using them for grazing with areas being fenced off. The local pest plant management authority is assisting with monitoring over the summer season (January 2017). The grower is actively using the Golden Dodder Management Plan document, developed in conjunction with pest plant management personnel and industry.

As at December 2016, no plants had been identified so the scale of the infestation is still unknown. Being a summer growing plant, the grower is monitoring the area closely in 2017.

The grower has discounted golden dodder being introduced by a contract harvester operator as the contractor was reaping cereals before arriving at the growers' property. It is possible that there has been contamination from other visiting vehicles.

Both lucerne stands are about eight or nine years old. The grower has also discounted the seed being contaminated as there hasn't been a positive reading previously and one of the paddocks had seed sown from a nearby paddock.

Quick Facts

- A lucerne seed grower had two high PCR test readings during the 2016 harvest.
- The paddocks have been taken out of seed production, fenced off, and now used for grazing.
- Grower production losses are in the region of $50,000, plus additional seed cleaning costs.
- Local pest plant management personnel have been supportive by providing advice on how to manage golden dodder and assisting with monitoring.

Interpreting PCR test results

PCR results are reported as the amount (picogram) of golden dodder DNA per gram sample. PCR test results will be presented as a single number and range from 0 to many thousand.

* **A PCR test result of 0 is considered a negative test result – no golden dodder was detected in the sample.**
* **Any PCR test result greater than 0 is considered a positive test result – golden dodder was detected in the sample.**

A DNA result of between 30-100 pg is roughly equivalent to one golden dodder seed per 100g of an unprocessed sample. All positive tests, even those with low results, can contain dodder. All positive PCR test results should be further investigated.

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Financial impact

The grower has determined that the production losses, taking the area out of seed production and using it for grazing, could be as high as $1,000 per hectare. A 52-hectare area means that total losses are approximately $50,000. In addition, there were additional costs for cleaning. According to a seed processor, a grower with dodder contamination will be charged about 40c per kilogram above the standard cleaning costs. This includes the added cost of cleaning down machinery – which takes 24 hours – powder coating for the magnetic roller, monitoring, laboratory sampling and disposal of offal. On a per tonne basis, this will equate to an additional $400.00 per tonne.

Growers also lose more seed due to the additional cleanouts, estimated to be 100kg more per tonne.

In the grower's words:

"We have also spent $4,000- $5,000 on fencing and gateways to isolate and manage this area. Hopefully, if we can contain the infestation, we can use some of the area for seed and hay again and the production loss over time won't be so great.

"Longer-term, the financial impact will be greater if the whole area needs to be quarantined. And there's the ongoing cost of managing sheep. If we graze the sheep on this area, then they must go straight to the meatworks. This means we stock less numbers as we cannot put them on other paddocks if we run out of feed. We've already had to supplementary feed as we couldn't move them to another paddock. We also have lost the hay production off this area."

Contacts

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Local Pest Plant Management Authority

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VICTORIA (Wimmera-Western)
Department of Economic Development, Jobs, Transport and Resources
Ararat, Victoria, 3380
Phone: 03 5355 0532

NEW SOUTH WALES (Southern)
Invasive Plants and Animals Unit
Department of Primary Industries
Goulburn NSW 2580
Phone: 02 4824 3737

Other Challenges

The grower is determined to manage the area closely and do as much as possible to identify where the area is, and deal with it accordingly. With the infested area being grazed it will make the task of finding dodder difficult, but monitoring the land and managing the difficulty of stock movements will continue.

For the grower, it was devastating to receive the very high readings as they take pride in what they do. He did not think there was a risk of weed seed contamination as there are no other reported cases in their area.

In the grower's words:

"I have heard nothing but praise for the PCR testing system. Everyone I've spoken to believes it is an excellent system. If there's a sniff of dodder it will show up in the PCR, so it's a great tool to minimise risk.

"I know dodder is a common weed in the USA and the American growers still survive. But dodder is not common here and as with pests and vermin, it's our responsibility to do the absolute utmost to get rid of it, or minimise it. And legislation states it's a category 1, declared weed in South Australia so action must be taken if there is a positive PCR result.

"We need an education program for growers that says: 'This is not someone else's problem - it could be yours tomorrow'. That might be a way of alerting people that dodder is around and get other growers to be more cautious."

Flowering lucerne

Tackling Golden Dodder - A Lucerne Seed Marketer Case Study

Based in South Australia

Background

Golden dodder (*Cuscuta campestris*) is a serious pest for lucerne seed production. It is a parasitic plant, which reduces crop yield and can kill its host plant. Seed contamination can have a harmful impact on the supply chain, reduce yield and increase the cost of cleaning. This contamination can make seed production uneconomical. In 2012, the South Australian Research and Development Institute (SARDI), in conjunction with Lucerne Australia, the peak industry body for the lucerne seed industry, developed a test to detect the presence of golden dodder in lucerne seed. The 'quantitative polymerase chain reaction' (PCR) test works by amplifying a small fragment of DNA. This PCR test can detect small amounts of DNA from golden dodder in large amounts of lucerne seed, even if a golden dodder seed is not found.

The Situation

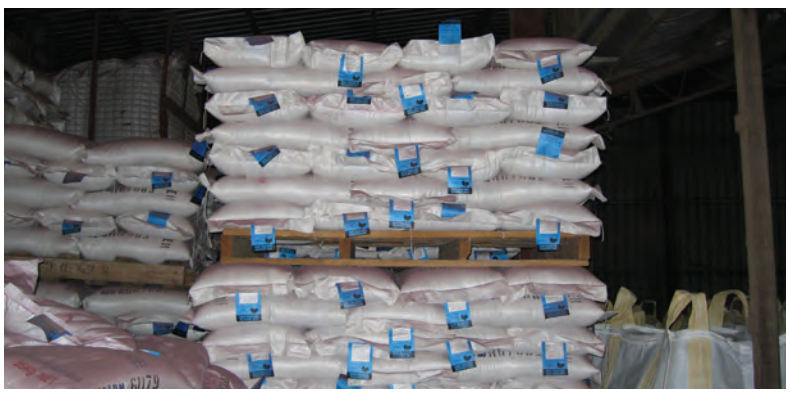
Buyers (marketers) of Australian certified lucerne seed, have confirmed their commitment to assist the industry, wherever possible, to manage the risk and impediment to trade that golden dodder presents. The marketers have supported the introduction of the PCR test for certified seed.

Interpreting PCR test results

PCR results are reported as the amount (picogram) of golden dodder DNA per gram sample. PCR test results will be presented as a single number and range from 0 to many thousand.

* **A PCR test result of 0 is considered a negative test result – no golden dodder was detected in the sample.**
* **Any PCR test result greater than 0 is considered a positive test result – golden dodder was detected in the sample.**

A DNA result of between 30-100 pg is roughly equivalent to one golden dodder seed per 100g of an unprocessed sample. All positive tests, even those with low results, can contain dodder. All positive PCR test results should be further investigated.



Quick Facts

- Lucerne seed marketers (buyers) support a PCR to identify the presence of golden dodder.
- This weed is internationally recognised as an undesirable/prohibited contaminant in lucerne seed for sowing.
- All lucerne exporters must declare lucerne seed shipments have been tested free of dodder seeds.
- A consignment of 72 tonne of blended seed was identified as containing dodder at port in 2012 originating from a contaminated six tonne line of seed that passed routine testing undetected. Although there are no exact estimates of the cost to the overall business, the cost of the contamination originating from the one single six tonne line was approximately $47,000.

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Golden Dodder and Markets

Golden dodder is internationally recognised as an undesirable/prohibited contaminant in lucerne seed for sowing, and needs to be managed to minimise the spread in seed production areas to ensure clean lines of seed are available to market to global customers.

The Middle Eastern & North African (MENA) region and particularly Saudi Arabia, is one of the key export destinations for Australian grown lucerne seed where dodder is a prohibited contaminant. All lucerne exporters must officially declare lucerne seed shipments are tested free of dodder seeds, through seed certification systems and ISTA testing protocols. This is part of the import requirements.

That said, the marketer confirmed that golden dodder is already present in the major lucerne seed production areas around the world. There are markets where producers and consumers of lucerne seed have learnt to manage it to minimise adverse impacts on production. The fact that there are already some occurrences within key lucerne seed production areas of Australia clearly necessitates that the focus needs to be on containment, rather than eradication.

The marketer is supportive of industry-wide initiatives to promote industry awareness and education and to contain the weed throughout the lucerne supply chain (e.g. seed growers, contract harvesters, seed cleaners and seed companies and other services).

Current protocols for inbound and outbound seed

The marketer stated that all lucerne seed deliveries contracted in South Australia and Western Victoria are sampled and PCR tested prior to seed cleaning. Any lines of seed containing golden dodder and the paddocks from which they originate that are picked up through this PCR process, are managed through partnerships with industry, in a manner to reduce the risk of any further cross contamination of other seed production paddocks and seed lines sold.

For imported lines of lucerne planting seed, there is a thorough internal protocol designed to reduce the risk of contamination with dodder to an absolute minimum.

Costs of Contamination

A grower with dodder contamination will be charged about 40c per kilogram above the standard cleaning costs. This includes the added cost of cleaning down machinery – which takes 24 hours – powder coating for the magnetic roller, monitoring, laboratory sampling and disposal of offal. On a per tonne basis, this will equate to an additional $400.00 per tonne.

Growers also lose more seed due to the additional cleanouts, estimated to be 100kg more per tonne.

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Other Challenges

- In regards to a risk of contaminated planting seed being imported from the USA, the marketer believes that bringing in smaller lots of seed (5-10kg at a time), is the best way to pick up any possible contamination.
- It is also the belief of the marketer that the PCR test be extended to testing locally produced seed (public and unidentified lucerne seed lots) as this is an area of risk.