DING DONG THE WITCH IS (NEARLY) DEAD – THE END IS IN SIGHT FOR THE RED WITCHWEED ERADICATION PROGRAM

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ABSTRACT

The first recorded detection of red witchweed in Australia occurred on a Mackay region sugarcane farm in July 2013. Following extensive delimitation surveillance, a total of eight neighbouring properties were confirmed as infested. In response, 2015 marked the inception of a joint funding initiative for an integrated research and treatment eradication program aimed at assessing and applying the most efficacious eradication strategies suitable for the Mackay environment. The objective was to extirpate the invasive species and exhaust its soil seedbank.

After almost a decade of consistent monitoring and eradication efforts, the Program is poised to successfully eliminate red witchweed by the projected deadline of June 30, 2025. To date, quarantine measures have been lifted from six properties (98% of quarantined land), with only 2.2 hectares remaining under active treatment. This collaborative approach involving industry and government stakeholders instils confidence that the Red Witchweed Eradication Program will be the first in the world to successfully eradicate this highly invasive plant species.

Keywords: red witchweed, *Striga asiatica*, eradication, surveillance, adaptive treatment.

INTRODUCTION

Red witchweed (*Striga asiatica*) pest details

Red witchweed (*Striga asiatica*) is a parasitic plant that is known to be one of the most destructive weeds affecting agriculture, particularly in tropical and subtropical regions. It is native to Asia, but it has spread to other parts of the world, including Africa, the USA and Australia. In countries like Australia, red witchweed is considered a serious threat to agriculture considering several of Australia's trade partners impose restrictions on importing seed and grain from areas where the species is established.

It is a small, annual plant with slender stems and leaves, and can grow up to about 40 cm in height. In Australia the plant generally has red flowers, although colour in Asian forms can vary from white, pink, yellow or orange. The plant reproduces by producing up to half a million tiny seeds that can remain viable in the soil for many years Shaw *et al*. (1962).

Red witchweed is an obligate parasite and cannot grow without a suitable host, including (but not limited to) cereal crops such as corn/maize, sorghum, sugarcane,

pearl millet and rice (Parker 2012). Research conducted in glasshouse trials by the Queensland Department of Primary Industries has also identified the major crops wheat and barley as suitable hosts. Certain pasture species have also been identified, and red witchweed was found to readily germinate in the presence of abundant grassy weed species found in Mackay including Crabgrass *(Digitaria violascens*) and Crowsfoot grass *(Eleusine indica*), as well as the native sedge Common fringe-rush (*Fimbristylis dichotoma*) Vitelli *et al*. (2018).

Red witchweed attaches to the roots of these host plants and extracts water and nutrients, which significantly impacts the health and yield of crops (Musselman 1980, Press *et al*. 1987) and can lead to severe losses.

It is particularly challenging to control because it is difficult to detect in early stages of infestation, as it lies dormant underground until it attaches to a host plant and then germinates, sets seed and dies within approximately three weeks. The long seed viability makes it a persistent weed problem once it has established itself in a field.

Infestation in Queensland

The detection of red witchweed in the Mackay region in July 2013 triggered an emergency response, commencing with comprehensive delimitation surveillance over a two-year span (2013-2015) followed by a ten-year regionally coordinated and nationally cost-shared eradication strategy. Partners in this initiative included federal and state governments (Queensland, New South Wales, and the Northern Territory) alongside key stakeholders in the agricultural industry, represented by Canegrowers, AgForce (in conjunction with Grain Producers Australia), and the Cattle Council (partnered with Meat & Livestock Australia).

A thorough analysis of potential risk pathways was performed to determine tracing and monitoring objectives. It was found that the principal method of dispersal was through the transport of soil that contained red witchweed seeds. To curtail the risk of further infestation, stringent quarantine protocols, movement restrictions, and detailed hygiene practices were imposed. Extensive and comprehensive surveillance clearly defined the infested area and confirmed that red witchweed was confined to eight neighbouring infested properties (IPs), six of which have now been released from quarantine.

RED WITCHWEED ERADICATION PROGRAM

The aim of the Program is to ensure that red witchweed is extirpated by 30 June 2025, with eradication confirmed following no further detections after a ten-year Proof of Freedom surveillance period.

Treatment activities

As described by Eplee (1992), eradication of red witchweed requires two control strategies running in parallel - the prevention of seed production and elimination of the persistent dormant soil seedbank. There are two main ways to prevent red witchweed seed production:

1) host denial (false host crop) or control/management of all true hosts
2) the use of selective herbicides.

The Program's eradication treatments incorporate techniques that accelerate red witchweed seedbank decline and prevent the production of new seed. Seeds can persist in the soil for many years - when buried at a depth of 152 cm, seeds can persist for up to 14 years, but when buried at 30 cm seed longevity is considerably shorter (less than 9 years) Bebawi *et al*. (1984). To expedite red witchweed seedbank run-down, the seeds need to be triggered into germination.

A range of successful techniques were identified during an extensive research trial to assess the efficacy of a range of control options applied in tropical Mackay conditions and then incorporated within an integrated control program. These techniques have significantly reduced the number of red witchweed detections and soil seedbank during the ten years of treatment (2015-2025).

<u>False and true host crops:</u>
'False host' species have roots that exude a stimulant to trigger germination but do not support attachment, subsequent growth and reproduction of red witchweed. The longer a host remains alive with its roots exploring the soil profile, the greater the likelihood of the roots encountering a red witchweed seed, therefore a continual crop of soybean accelerated seedbank depletion (Figure 1). The roots of 'true host' species (such as sugarcane) exude a stimulant to trigger germination of red witchweed seeds, supporting the subsequent growth through to flowering and seed-set. Corn was selected as the preferred true host for use in the Program and planted within the soy rows (Figure 2). As the soybean does not support attachment and growth, the only visible evidence of red witchweed presence is when it germinates and emerges attached to the corn. As corn can host red witchweed through to seed set, intensive surveillance every 5-10 days has been conducted on these corn rows.

Figures 1 & 2. False host crop (soybean, left) and true host crop (corn, right)

<u>Fumigants:</u>
Fumigants have demonstrated success at killing witchweed within the soil prior to cropping Jacobsohn *et al*. (1988). Ethylene application is an integral part of the red witchweed eradication program in the USA and has been used successfully during the Program in Mackay. Ethylene gas disperses through the soil profile and destroys seeds within the soil seedbank through suicidal germination (the seed is stimulated to germinate but has no available host). It has been applied with both a manual hand-held point injector, and a tractor-mounted delivery system with tines and rollers to assist the lateral and vertical spread through the soil (figures 3 and 4).


Figures 3 & 4. Ethylene delivery systems

Dazomet is a powered dry formulation fumigant that is applied evenly to the soil surface, and research has shown that the application of dazomet effectively reduced the seed viability of red witchweed to 5% after three consecutive annual applications. Dazomet has been used after incineration of new red witchweed detections to destroy any further seeds.

Herbicides:

In sites where hosts and fumigants cannot be used, maintaining the soil bare of potential true weedy hosts with regular spraying of herbicides for the control of broadleaf weeds and grasses can also be a successful tool at reducing the red witchweed soil seedbank (trials showed a decline in viability to 28% after three years). Pre- and post-emergent herbicides have been strategically applied and will also kill any red witchweed that has attached to the roots of the host plants. Targeted, selective and knockdown spraying is conducted year-round along with crop maintenance applications. To support an integrated weed control approach, tractor grubbing, burning and grazing are conducted to control hosts and also facilitate effectiveness of visual surveillance.

Surveillance

Infested paddocks are surveyed every 5-14 days to enable detection prior to seeding, with this interval reduced to 5-10 days during the peak emergence period from December to May. Surveillance is conducted on transects 2-3m apart, with the surveillance interval guided by the level of visibility, which is influenced by terrain and conditions (vegetation height, undulation etc.) and the need to detect very small red witchweed plants. Spatial data (survey tracks and any red witchweed detections) are recorded on an iPad using GPS (tracks) and DGPS (detections) to precisely track surveillance effort, distribution of infestation and inform mapping (Figure 5).

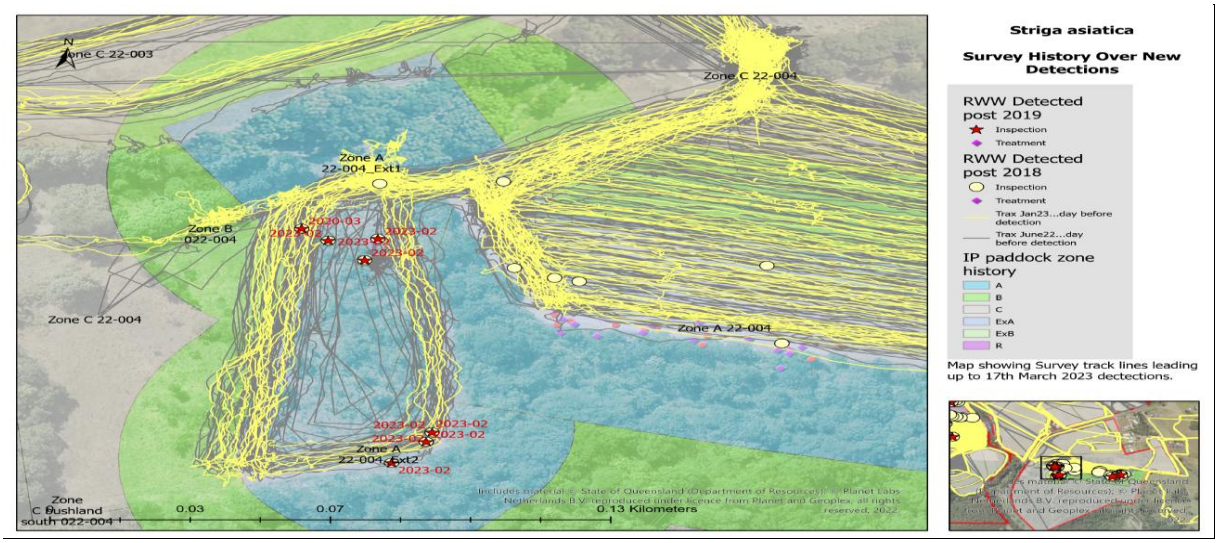

Figure 5. Spatial representation of surveillance frequency and detections

Results

Area of operations (to 31 March 2025)

Of the original eight IPs quarantined under the Program, six have been released from quarantine and treatment. A total of 122.2ha (98%) has been released from quarantine, with only 2.2ha (2%) still subject to treatment activities.

Detections

After several years of steady decline, routine surveillance detected a dense infestation on one of the IPs in January 2024 (Figure 6). These detections were on a paddock adjacent to a quarantined paddock and had never been subjected to treatment activities or had previous detections. All new detections were immature plants (no developed seedpods) and were immediately destroyed. Intensive treatment activities (herbicide application, ethylene, dazomet and soybean cropping) have been applied for the past twelve months. An additional 14 plants were detected on this same paddock in February and March 2025.

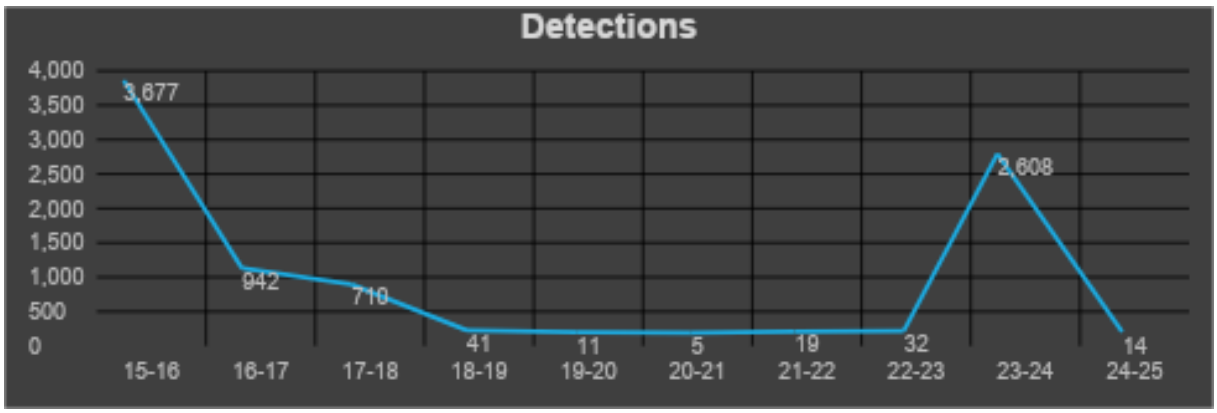

Figure 6. Red witchweed detections 2015 - 2025

Release from quarantine

The implementation of a scientifically based point system for release of paddocks from quarantine is founded on the research conducted since 2015 identifying best-practice management under local Mackay conditions.

Infested paddocks are assigned a number value according to the treatment activities and surveys employed since 2015, with those treatments or surveys that contribute the most towards eradication qualifying for more points than those with lower impacts. The points system reflects the number of treatments and surveys conducted on each paddock, as well as the number and dates of red witchweed detections. The higher the number of points, the greater the confidence that red witchweed has been extirpated from the paddock.

If any red witchweed is detected in a paddock, the score reverts to zero and accumulation of points must start again. Once a paddock achieves a score of 100 it is eligible to be released from quarantine. This points system provides a systematic way of releasing sites from quarantine, and in the USA less than 1% of the sites released through this procedure have later been found to contain red witchweed (Eplee 1992).

Based on this points system, 122.2ha (98%) of quarantined land has been released and returned to production.

Seedbank viability

In 2016, canisters containing red witchweed seeds were buried at five different depths on paddocks within each IP and exposed to normal treatment activities in the field. A selection of these canisters was removed when blocks reached the 100-point criteria for release from quarantine and seed viability assessed.

At the completion of almost ten years of treatment (31 March 2025) there has been a demonstrated 99.98% decline in the soil seedbank. This research indicates that the treatment activities and 100-point quarantine release system have been effective in developing confidence that extirpation of red witchweed has been achieved.

PROOF OF FREEDOM SURVEILLANCE

After paddocks are released from quarantine, they are subject to periodic surveillance for a ten-year period to demonstrate Proof of Freedom (following the USDA model for red witchweed eradication), requiring no further detections to confirm red witchweed eradication. The points system implemented in the quarantine release, and no detections during the ten-year Proof of Freedom period will provide a credible level of confidence that red witchweed has been eradicated. At the end of this ten-year post-release and surveillance period, all Program activity will be terminated, and the formerly infested site will be treated the same as any other non-infested area.

ACKNOWLEDGEMENTS

The authors extend their gratitude for the financial support given by all contributors to the nationally cost-shared Red Witchweed Eradication Response. Additionally, sincere appreciation is expressed to the Infested Property (IP) owners who have faced

significant disruptions to their daily lives and incomes yet have continued to steadfastly support the eradication efforts. Lastly, the team members dedicated to the red witchweed cause deserve commendation for their unwavering commitment to conducting surveillance and treatment operations consistently throughout the year, even under the occasionally harsh tropical environmental conditions they encounter.

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