Milestone Report

Project title:

Integrated Pest Management of Nematodes in Sweetpotatoes

Project code:

PW 17001

Milestone number:

106

Project leader:

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Confidentiality:

Is this report confidential?

☒ No

☐ Yes (whole report)

☐ Yes (sections of report are confidential)

If sections of the report are confidential, list them here:

Milestone description:

Latest findings on field trials communicated to industry.

Nematicide trials start.

Sampling strategies for soil biology diagnostics determined.

Milestone achievement criteria:

Update on long term farming system and grower trials

Round 2 nematicide trials. Status of field trials communicated.

Report on survey results and assess biosecurity risks.

Sampling strategies determined.

Project reference group meeting held and minutes provided.

Funding statement:

This project has been funded by Hort Innovation, using the Hort Innovation sweetpotato research and development levy, co-investment from Department of Agriculture and Fisheries, Queensland and contributions from the Australian Government. Hort Innovation is the grower-owned, not-for-profit research and development corporation for Australian horticulture.

Abbreviations

ASPG	Australian Sweetpotato Growers Inc.
BRF	Bundaberg Research Facility
CQU	Central Queensland University
DAF	Department of Agriculture and Fisheries
DES	Queensland Department of Environment and Science
ESP	Ecosciences Precinct
GRF	Gatton Research Facility
NTF	Nematode Trapping Fungi
PRG	Project Reference Group
PT	Pathogen Tested
RKN	Root-knot Nematode
SARDI	South Australian Research and Development Institute
USQ	University of Southern Queensland

General project overview

Nematodes are an important pest of sweetpotatoes, with current estimates suggesting they cost the Australian industry $20 M per year (ASPG pers. com.). This project aims to extend existing knowledge and develop new knowledge specific to sweetpotato farming systems on soil health and nematode management. Surveys will be conducted across production areas to identify nematode species present and a range of management options such as volunteer and host weed control, suitable summer and winter cover/rotation crops, low/minimum till, long term beds and nematicide efficacy will be investigated.

Summary

This reporting period saw the recommencement of on farm surveys particularly in northern NSW, with the relaxation of Covid-19 restrictions. However due to long running drought conditions over most areas nematode numbers continue to be low. Trial work on the long-term farming systems trial in Bundaberg continues with the second commercial sweetpotato crop planted in the intensive block. The previous rotation crop (Jumbo sorghum) has been incorporated and organic amendments were applied and incorporated at bed formation. The second round of cover crops in the extensive trial (preformed beds) have been mulched off and the block is being planted to signal grass this week.

Soil sampling to provide information on nematode populations, physical properties and biological activity continues throughout the long-term trial and pre plant at the nematicide trial site and future cover crop demonstration sites. A suitable site has been identified in Bundaberg to conduct nematicide trials. Trial planning is underway with a planting date set for the second week in March 2021.

A number of host range pot trials (44 ongoing) continue to evaluate nematode resistance or susceptibility of potentially suitable cover crops for use in sweetpotato faming systems. Pathogenicity pot trials also continue to evaluate commercially grown sweetpotato cultivars and gauge their susceptibility or resistance ratings to nematode infection.

A second herbicide trial is underway to investigate ‘plant back’ effects of pre plant herbicide treatments on sweetpotatoes post planting. A second factsheet, *“Environment and herbicide performance”* has been completed and distributed to growers.

Many activities are tracking ahead of required timeframes. Some activities such as herbicide fact sheets, microarthropod and nematode trapping fungi monitoring, intensive soil assessments and continuing cover crop host range and sweetpotato cultivar pathogenicity trials are additional activities to this milestone (106) requirements.

Achievements

Update on long term farming system and grower trials communicated to industry.
Nematicide trials start.
Status of field trials communicated.
Report on survey results and assess biosecurity risks.
Sampling strategies determined.
Project reference group meeting held and minutes provided.

Update on long term farming system and grower trials

As COVID-19 control restrictions at the time, limited the number of attendees at research facilities, it was not possible to conduct traditional field days. Therefore, online project updates were provided to both the Project Reference Group (PRG) and sweetpotato growers during December 2020.

Cover Crop Phase

Monitoring of the long-term trial has continued as planned. As the cover crop phase followed a sweetpotato planting with relatively low nitrogen requirements, urea was applied a rate of 100Kg / Ha to the White French millet in both the Intensive and Extensive trial blocks in September 2020. A follow up application at the same rate in November ensured adequate nutrition for the Jumbo sorghum, the next phase of the cover crop regime.

Figure 1: Manual application of urea to the White French Millet

Figure 2: Irrigation being applied to the White French Millet

Extensive Trial

Extensive trial plan

- Three Sweetpotato crops (cultivar Beauregard) in 5 years with longer rotation breaks
- Combinations of organic amendments vs Vydate vs no amendment
- Early bed formation (soon after harvest)
- Amendments incorporated at early bed formation (in a band), in a V-shaped furrow prior to planting, or both
- Rotations sprayed out or cut/mulched
- 40 plots (10 treatments X 4 reps)

Table 1: Treatments in the Extensive trial

Treatment No	Extensive - 10 treatments x 4 reps
1	Grass/brassica + Nematicide (Vydate)
2	Grass/brassica + Nil
3	Grass/brassica + V furrow amendment
4	Grass/brassica + Incorporated amendment
5	Grass/brassica + Double amendment
6	Grass/legume + Nematicide (Vydate)
7	Grass/legume + Nil
8	Grass/legume + V furrow amendment
9	Grass/legume + Incorporated amendment
10	Grass/legume + Double amendment

Figure 3: Left, the White French millet was sprayed off on the preformed hills. Right, The Extensive block.

By mid-November 2020, the White French millet had reached maturity and was starting to set seed, so was sprayed out with herbicide (Glyphosate). The hills were kept intact in line with low till systems and soil health principles.

As planned, two new cover crops were sown into the 40 plot areas on the 30th of November 2020.

1. Sunn Hemp @ 20kg /ha x 20 rows - Grass / Legume plots.
2. Nemsol @ 10 kg /ha x 20 rows - Grass / Brassica plots.

Due to hare damage, the Grass Brassica plots were re sown in early December 2020. To alleviate the threat of waterlogging from heavy summer rainfall, the furrows were ripped to facilitate drainage. To aid in weed control, herbicides were applied to the furrows in January 2021.

In February 2021, a visual assessment of flowering percentage and ground coverage was made. Using a 50cm quadrant, biomass samples were taken from the 2 m buffer zones at each end of the rows. Wet and dry weights were recorded; Brassica samples were then ground and stored at minus 20^0C for future analysis to determine glucosinolate levels. All plants were then mulched off on the 17th of February 2021 while the Sunn Hemp stems were still soft to aid breakdown.

Figure 4: Rotation crops in the Extensive trial. Left, Sunn Hem and right Nemsol.

Figure 5: Rotation crops mulched off in the Extensive trial. Left, Sunn Hemp, right Nemsol.

Intensive Trial

Intensive trial plan

- Four Sweetpotato crops (cultivar Beauregard) in 5 years with shorter rotation breaks
- Combinations of organic amendments vs Nimitz vs no amendment
- Organic matter/compost incorporated at bed formation or in a furrow prior to planting
- Rotations also incorporated at bed formation
- 25 plots (5 treatments X 5 reps)

Table 2: Treatments in the Intensive trial

Treatment No	Intensive - 5 treatments x 5 reps
1	Organic matter
2	Compost
3	V furrow amendment
4	Nematicide (Nimitz)
5	Nil

The White French millet in the Intensive trial was rotary hoed on the 14th of October and incorporated into the soil following grower practices. The following week, Jumbo Sorghum was sown at the rate of 40kg/Ha (double rate) and irrigated using solid set irrigation.

In mid-December, the Jumbo sorghum was mulched and incorporated using a rotary hoe. Preplant soil samples was collected from all 25 rows in Jan 2021 and sent for a complete nutrient analysis. Prior to bed formation a basal fertiliser was applied at 300kg / Ha, following grower practice.

Figure 6: Left White French millet in the intensive trial. Right, after incorporation of WF millet.

Figure 7: Jumbo Sorghum was planted in the Intensive block after incorporation of WF millet.

Intensive trial amendments

Amendments were applied to the organic matter, compost and V furrow plots the Intensive trial block on the 19th January 2021. The compost treatment plots each received 55kg (3.5 t/Ha) of compost whilst the organic matter plots received a mixture of 56kg (3.6t/Ha) of poultry manure and 33.6kg (2.2t/Ha) of sawdust, all treatments being equivalent to 50t/ha. Amendments were then incorporated during sweetpotato bed formation. All remaining plots in the Intensive trial were then bed-formed in preparation for planting of the next sweetpotato crop. Compost (42.5kg, 2.7t/Ha) was then placed into a v shaped furrow in the V furrow treatment plots.

The second commercial sweetpotato crop was planted on the 29th of January 2021 at 20cm spacing. Scuffling and a low-rate spray application of Fusillade took place at 2 weeks after planting followed by a boom spray application of liquid fertiliser at 5L / Ha. Scheduled irrigation is being delivered throughout the block using Netafim streamline X, at a rate of 1800 L /Hr. Fortnightly soil and leaf tissue samples will be collected for nitrate analysis. Weekly monitoring of irrigation, pest and disease presence and weeding continues.

Figure 8: Organic amendments incorporated during bed forming of the Intensive trial.

Figure 9: Intensive block planted with commercial crop. Right, Rach Langenbaker with the planting crew.

Nematode analysis

Monitoring of the long-term trials has continued as planned. Soil samples (195) for nematode, physical soil properties and soil biology analysis were taken just prior to planting of the Intensive block commercial crop. Results will provide information on any correlations between soil characteristics, Root Knot Nematode (RKN) populations and soil biology. Post-rotation crop counts from both trials are underway and will be reported in milestone 107.

Nematicide trial plans in place

With the relaxation of Covid travel restrictions, several sites were surveyed from October 2020 to January 2021 across the Bundaberg, Rockhampton and Cudgen regions. Effects of the long running drought and lack of water availability have been reflected in the nematode counts with low numbers identified from most blocks. Despite this, in late January, a possible trial site with moderate numbers of nematodes, was identified in Bundaberg. The block will be resampled prior to planting as recent rainfall in this region should boost the nematode population. A trial plan has been designed for the block and approved by a DAF biometrician. Four treatments are planned, Nil (control), 2 Nimitz application methods, Vydate, and Metham sodium. The trial will be planted with the nematode susceptible sweetpotato variety Beauregard. Population levels of plant parasitic and free-living nematodes, microarthropods and nematode trapping fungi will be determined preplant and post-harvest. Harvested roots will be assessed for marketability and nematode damage.

Status of field trials communicated.

Winter cover crop demonstration trial

As previously covered in M105, cover crops were grown to investigate their suitability to control parasitic nematodes. The grower demonstration site selected in Bundaberg was planted on the 21st of May 2020. Eight different winter cover crops from grass (Poaceae) and Brassica families were chosen based on their seasonal suitability and seed availability with a bare fallow used as a control. A biomass assessment was conducted on the 2nd of September 2020 and soil samples were collected. Glucosinolate analysis results are pending.

Figure 10: Left to Right, cover crop trial site, biomass and flowering assessment.

While the different cover crop treatments showed a reduction of RKN between sampling periods, the results must be looked at with caution. This was an observation trial and not replicated, so cannot be interpreted by a statistician. There is a possibility that sampling variation could be a source of the lower counts, as nematode numbers are often patchy across a field or along a row. Cooler winter temperatures may also have had an effect on lowering the nematode numbers.

The Brassica cover crop species attracted large populations of various insect pests and required more water than other rotation crops making them less attractive for some growers. Considering the nematode reduction trend, a replicated field trial may be worth pursuing, however inclusion of Brassica species into the crop rotation would depend upon grower interest and the viability of growing this crop considering water availability and the requirement for pesticide application.

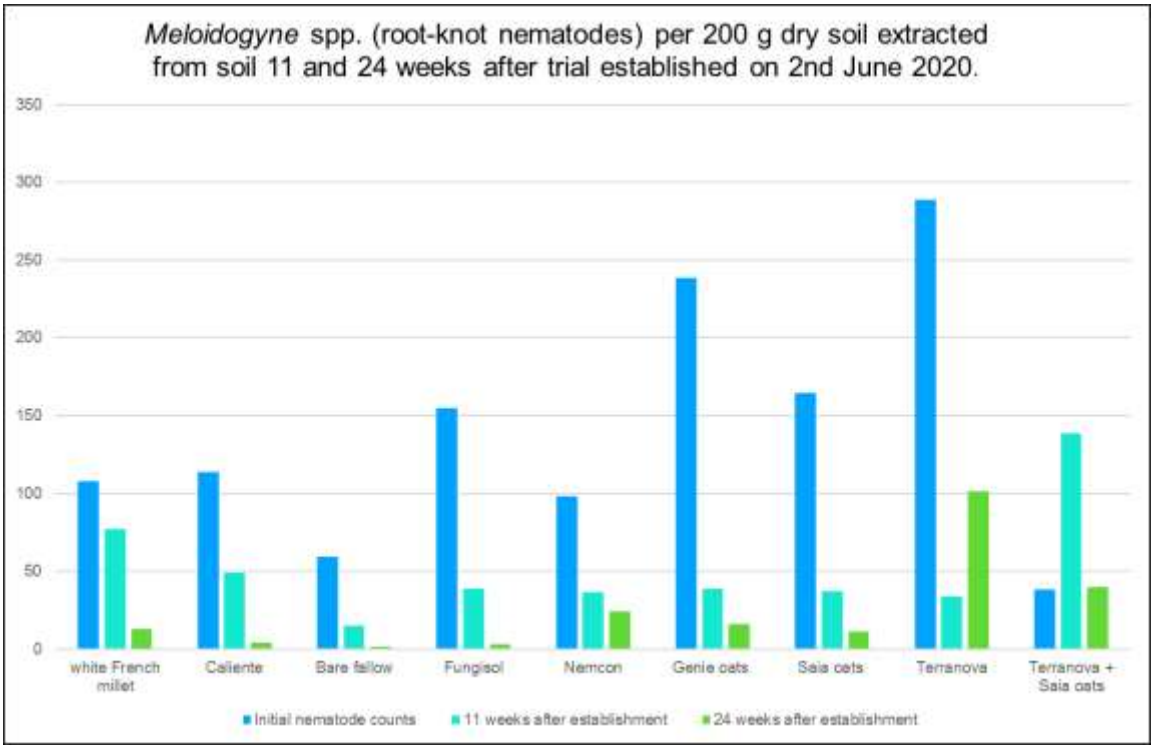

Figure 11: Cover crop trial RKN counts preplant, 11 and 24 weeks post planting.

Report on survey results and assess biosecurity risks.

Addressed in milestone 103 and 104. Field surveys to understand region specific nematode species occurrences and identify any potential biosecurity issues were undertaken throughout the major cropping regions.

Since the project commenced, over ninety survey samples along with a number of diagnostic samples have been received and processed by the DAF nematology team at ESP. Plant-parasitic nematodes were extracted, identified and quantified from all samples and results standardised to per 200 grams of dry weight equivalent soil. To give an overall indication of the soil's biological status, free-living nematodes were also identified. Eighty soil samples were sent to SARDI for molecular identification of root-knot nematode.

Initial results show that RKN (*primarily Meloidogyne incognita* and *M. javanica*) is widespread in the industry and reniform nematode appears to be extending its geographical range. A detection in the Lockyer valley is believed to be the most southerly recording of this species in Australia to date. SARDI have run the first 45 survey samples. A report by Grahame Stirling, Jenny Cobon and Wayne O'Neill has been sent to SARDI for editing.

Plans for intensive surveys were developed to sample a representative group of fields, both pre-plant and post-harvest. Information on each field's soil type and previous cropping history has been collected and will be used to assess the impact of these factors on nematode occurrence and population density. Drought conditions especially during the latter half of 2019 and throughout 2020 prevented further surveys as dry soil does not give a true representation of nematode numbers. Recent rainfall events in Queensland and Northern New South Wales and relaxation of Covid restrictions allowed surveys to re

commence in October 2020.

Final survey results – DAF morphological identification from 83 survey sites

- Root-knot nematode is by far the most important nematode pest of sweetpotato – with 50 of 83 sites across all regions identified with root-knot nematode (RKN) numbers ranging from 1 – 3,413/200-gram dry soil. In the Bundaberg region, 28 of 45 sites were identified with root-knot nematode while in the Cudgen region 15 of 17 sites were identified with RKN. RKN was recorded in all regions and in the Bundaberg and Cudgen regions it was the nematode recorded in the highest numbers and with the greatest frequency.

- *Rotylenchulus reniformis* was recorded in four sites in Central Queensland, three in Bundaberg and one in South East Queensland and poses a serious threat to the industry. This new detection in South East Queensland is a long way from its known geographic distribution. This nematode has not been found in Cudgen or the Atherton Tablelands to date.

- *Pratylenchus zeae* was the most common lesion nematode detected. It was detected in 24 sites in the Bundaberg region, five sites in Cudgen, six sites in Central Queensland, four sites in South East Queensland and two sites on the Tablelands. The effects of *P. zeae* on sweetpotato varieties needs to be assessed.

- Spiral nematodes were relatively common, but are not a cause for concern as they have little impact on root growth

- *Rotylenchulus parvus* was detected in relatively low numbers suggesting sweetpotato is not a good host. It has not been detected in Central Queensland to date but is a common nematode in other regions.

- Stubby, stunt, ring and dagger nematodes were recorded in low populations also suggesting sweetpotato is not a good host of these nematodes.

SARDI molecular identification of *Meloidogyne* spp. from 80 sites

- DNA of *Meloidogyne javanica/incognita/arenaria* was identified in 54 of 80 sites using their non-specific assay.

- In 21 of these 54 samples, SARDI were not able to further identify the RKN to species level.
- SARDI identified eight sites with their *Meloidogyne javanica/incognita/arenaria* non-specific assay from which DAF were unable to extract and identify RKN

- DAF identified seven other sites with RKN where SARDI were unable to identify DNA of *Meloidogyne javanica/incognita/arenaria* using their non-specific assay

- In the Bundaberg region, *M. javanica* was the most dominant species identified from 16 of 43 sites tested, with *M. incognita* identified from five of 43 sites and *M. arenaria* identified from two of 43 sites

- In the Cudgen region, *M. javanica* was identified from three of 15 sites tested, with *M. incognita* identified from four of 15 sites and *M. hapla* identified from six of 15 sites

- In the Central Queensland region, *M. javanica* was identified from two of 12 sites tested

- In the South East Queensland region, *M. hapla* was identified from one of six sites tested

- In the Tableland region, *M. javanica* was identified from one of four sites tested, with *M. incognita* identified from one of four sites.

Biosecurity issues

- On farm biosecurity to stop the spread of any plant-parasitic nematodes to fields that may potentially be free from nematode pests of sweetpotato needs to be reinforced. Measures should include cleaning farm equipment, personal equipment, and using clean planting material to aim to stop/reduce the movement of potentially contaminated soil.

- Potential spread of *Rotylenchulus reniformis* from its known geographic distribution as this nematode is a known constraint to sweetpotato production in the USA.

Sampling strategies determined

Follow on intensive surveys are in place. Plans for intensive surveys were developed to sample a representative group of fields, both pre-plant and post-harvest. Surveys have been completed in central Qld and Cudgen, with a handful of surveys to be conducted during the next few weeks in far north Qld and Bundaberg. Information on each field's soil type and previous cropping history has been collected and will be used to assess the impact of these factors on nematode occurrence and population density.

Project reference group meeting held minutes provided.

A project reference group meeting was held on the 14th of December 2020. Meeting minutes were provided in January 2021.

Additional achievements

Resistance pot trials to assess potential cover crops continue

Resistance to plant-parasitic nematodes is determined by the capacity of the nematode to multiply on a plant, with high multiplication rates indicating susceptibility and low multiplication rates indicating resistance. Levels of resistance or susceptibility were determined by inoculating plants with a known number of nematode eggs (initial population density Pi), measuring final population density (Pf) and then making the following calculation: Reproduction Factor (RF) = Pf/Pi (Table 2).
Since not all eggs in inoculum are capable of hatching and invading roots, a conservative figure of 1/10 of the Pf was used as Pi, i.e., 1,000 as each plant was inoculated with 10,000 eggs of either *Meloidogyne incognita* or *M. javanica*.

Table 3, Resistance categories

Reproductive Factor	Resistance Rating
> 100	Highly Susceptible (HS)
10 - 100	Moderately Susceptible (MS)
1 - < 10	Slightly Susceptible (SS)
0.1 - < 1	Resistant (R)
< 0.1	Highly Resistant (HR)

A mixed species experiment including oat cultivars (Saia, Swan, Eurrabbie and Genie), sorghum cultivars (Dyna Powa and Dyna Dan) and white French millet was inoculated with two species of root-knot nematodes (*M. incognita* and *M. javanica*) to determine the host status of these plant species.

- *Avena strigosa* cv. **Saia** is resistant to *M. javanica,* but moderately susceptible to *M. incognita.*
- *Avena sativa* cv. **Swan** is highly resistant to both *M. incognita* and *M. javanica*.
- *Avena sativa* cv. **Eurrabbie** is resistant to *M. incognita,* but slightly susceptible to *M. javanica.*
- *Sorghum* sp. cv. **Dyna Powa** is resistant to both *M. incognita* and *M. javanica*.
- *Sorghum* sp. cv. **Dyna Dan** is resistant to *M. incognita,* but slightly susceptible to *M. javanica*.

Current and future pot experiments – sweetpotato and RKN

Further glasshouse experiments to determine host range resistance of more rotation crop species and of

new sweetpotato cultivars are presently underway.

- Exp 11: Six SP varieties (6, 8, 8, 10 11P & 12P) X Meloidogyne incognita and M. javanica
- Exp 12: Six oat varieties (Algerian, Carrolup, Williams, Swan, Austin & Comet) + two sorghum varieties (Lush and Dyna Power,) X Meloidogyne incognita and M. javanica
- Exp 13: Four wheat varieties (Bennet, Elmore, Naperoo & Illabo) + two barley varieties (Dictator & Shepherd) X Meloidogyne incognita and M. javanica
- Exp 14: Six SP varieties (7, 13, 14, 15, 16 & 17) X Meloidogyne incognita and M. javanica

An update on nematode resistance ratings of cover crops trialed to date was distributed to growers in January 2021.

Herbicide review and pot trial continues, herbicide fact sheet developed

During grower meetings farmers stated they were unsure if herbicides used in fallow and pre-plant situations could affect newly planted sweetpotato cuttings. To study this further, a second herbicide trial has been initiated at Walkamin Research Facility. Twelve herbicides that have registration for control of convolvulus species are being studied to gauge if plant back periods may be required after their use.
The trial is a randomised split plot design with four replications, twelve herbicide treatments and three planting times. The twelve herbicides consist of two pre-emergent herbicides, four pre- and post-emergent herbicides (applied as pre-emergent) and six plant contact herbicides. The pre-emergent applications were made 60 days before first planting. The plant contact herbicides were applied 1 day before first planting. The second and third plantings were respectively eight and seventeen days after the first planting. Data is currently being collected.

The factsheets "*Herbicides what are they?*" and "*Environment and herbicide performance*" have been approved by DAF and Hort Innovation and released to farmers in October 2020.

Outputs

- PRG meeting held in December 2020 and minutes provided.
- Two project team meetings conducted via Microsoft Teams (October and December 2020) and face to face project meeting held at Bundaberg Research Facility in January 2021.
- Amendments applied to the Intensive trial block, within the long-term farming systems trial, soil samples collected and second commercial sweetpotato crop planted.
- Third round of cover crops planted to Extensive trial block.
- An update on nematode resistance ratings of cover crops trialed to date was distributed to growers in January 2021.
- On farm demonstration cover crop trial completed
- Protocols continue to be refined for biological soil monitoring tools, (microarthropods extraction and NTF culture).
- Follow on intensive surveys continue on identified selected blocks; letters sent to growers with test results after each sampling.
- Second herbicide trial under way.
- Two herbicide fact sheets (*Herbicides, what are they? and Environment and herbicide performance*), approved and distributed to growers.

Outcomes

Growers have increased knowledge on nematode resistance of additional cover crops species for use in sweetpotato production systems.
Capacity building continues as sweetpotato researchers develop protocols and enhanced skills for culturing NTF and extracting microarthropods from soil samples.
Growers have increased understanding of herbicides in relation to sweetpotato production systems.

Intellectual property, commercialisation and confidentiality

No project IP, project outputs, commercialisation or confidentiality issues to report

Issues and risks

Although restrictions are now somewhat more relaxed, COVID-19 continues to be a risk. To date the project has been continuing to follow recommended practices. Although field days and other planned gatherings have been replaced by webinars and teleconferences, it is anticipated that field days will be able to be resume during 2021. Field activities are following recommended social distancing and hygiene protocols. This is expected to continue while this disease remains a threat. Any future Qld border closures may pose some restrictions on movement to/from NSW. Alternative arrangements have been put in place by enlisting local agribusiness staff to conduct soil sampling.

Other information

No additional information to report.

Appendices

Attachments

Attachment 1: Herbicide fact sheet Number two.

Attachment 2: Updated summary of resistance to RKN, January 2021.