RUSSIAN WHEAT APHID FACT SHEET

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

NATIONAL
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An integrated pest management approach to managing RWA

KEY POINTS

- Russian wheat aphid (*Diuraphis noxia*; RWA) was first found in Australia in 2016. It is now established in south-eastern Australia and is a manageable pest of wheat and barley. In 2020 RWA was detected in Western Australia for the first time
- Although RWA does not transmit viruses, direct feeding pressure can reduce cereal yields if infestations are severe. During feeding, it causes chlorosis and necrosis of infested leaves, can disrupt head development and sometimes leads to plant death
- Russian wheat aphid lives on a range of weedy grasses, especially barley grass and *Bromus* species. It persists throughout the summer green bridge on grassy weeds, volunteer cereals, and warm-season grasses
- Presence of RWA in a region does not automatically result in presence of this aphid in crops and presence in crops does not automatically result in yield loss (severe infestations are rarely observed)
- A diversity of natural enemy species have been observed feeding on, infecting and parasitising RWA in Australian regions
- Monitor for aphid abundance in establishing crops during autumn and winter. Use thresholds to determine cost effectiveness of chemical intervention
- Insecticide seed treatment only for RWA control does not appear to be a cost-effective option in many instances and adds to the risk of insecticide resistance emerging in pest species
- The presence or absence of an autumn green bridge is a key factor influencing risk of early crop infestation each season
- Growers should take an integrated pest management approach and implement the 'FITE' strategy (Find, Identify, Threshold approach and Enact)

Photo: Elia Pirtle, Cesar Australia

Russian wheat aphid.

FITE

FIND Look for aphids in crops and volunteer cereals using characteristic feeding damage symptoms.

IDENTIFY Positively identify RWA (consider consulting with an industry specialist).

THRESHOLD APPROACH Before implementing chemical-based management, consider thresholds for control, the presence of natural aphid enemies in the crop, crop growth stage and the risk of economic yield loss.

ENACT Take appropriate action to limit economic loss. Manage your next steps including encouraging beneficial insects and protecting pollinators before implementing chemical control options.

Find symptoms

In wheat and barley, look for:

1. Whitish, yellowish to pink-purple chlorotic streaks along the length of the leaves.
2. Longitudinal rolling of leaves where the aphids shelter.
3. A flattened habit.

Photo: SARDI

RWA symptoms: striping and rolling of leaves, flattened habit and pink-purple chlorotic streaks along leaf length.

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Symptoms

Symptoms of RWA feeding can be confused with a nutrient deficiency, herbicide damage or bleaching from herbicides such as diflufenican.

Early autumn infestations of RWA can build up in spring and affect the development of major yield contributing leaves (flag leaf, leaf two and leaf three). Spring RWA infestations (after GS40) are rare although they can cause some symptoms and are not expected to impact on yield.

Infestation of the flag leaf may result in curling of the leaf, trapping the awn and preventing the head from completely emerging. This produces a gooseneck head and, as a result, the grain does not properly mature. Heads can also appear bleached.

RWA usually hides close to the stem and inside rolled leaves. Check inside and at the base of rolled leaves to confirm presence of aphids (RWA is found almost exclusively on tillers with symptoms, however tillers with symptoms do not always host RWA).

Photo: Elia Pirtle, Cesar Australia

RWA symptoms: rolled leaf.

Photo: Elia Pirtle, Cesar Australia

RWA symptoms: goosenecked head.

Identify the aphid

Once aphids have been detected, use a hand lens or smartphone macro lens to gain a better view of the aphid features, such as the antennae, the body shape, the siphuncles ('exhaust pipes') and the tail area. To identify RWA from other aphids, the key identifiers between these species are:

- pale green colour
- approximately 2mm long
- elongated spindle-shaped body
- short antennae (in comparison to other cereal aphids)
- the apparent lack of siphuncles on the top of the rear end of the body
- a dual tail (cauda) at the rear end (visible from a lateral view only)

Other aphid species (oat and corn aphids) sometimes cohabit with RWA inside rolled leaves.

Russian wheat aphid vs. other cereal aphids

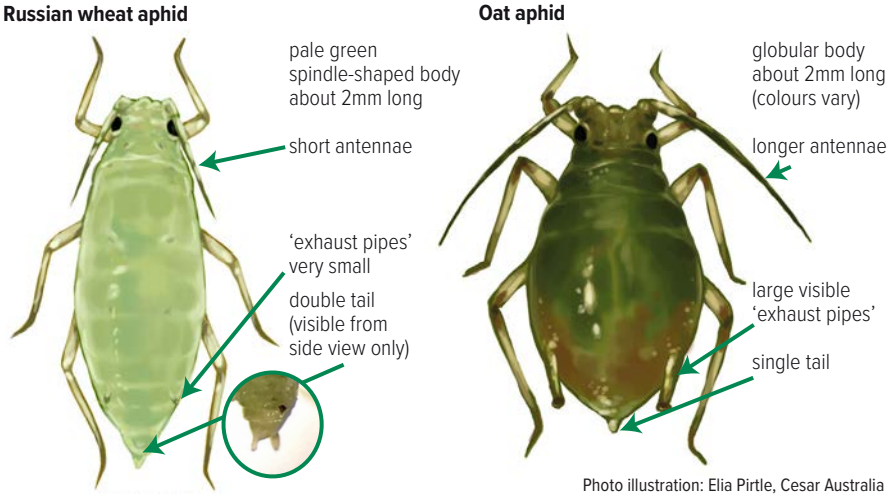


Photo illustration: Elia Pirtle, Cesar Australia

Threshold approach

Risk of economic yield loss is strongly influenced by the level of RWA infestation during booting and grain fill, which can be predicted through the number of inspected tillers with RWA around GS30.

Action to control RWA should only be taken if aphid infestation levels are likely to surpass the 'Economic Injury Level' (EIL). The EIL is reached when the expected yield loss resulting from feeding equals the cost of pest control. If pest densities surpass this level, losses will be greater than the cost of control. In this case, aphid control action is the most economically viable option.

The percentage of tillers with RWA and the approximate time until head emergence in the crop are key factors in determining if the EIL is likely to be surpassed.

However, market prices, management costs (pesticides and application costs), and time between crop inspection and pest control should all factor into the decision as well.

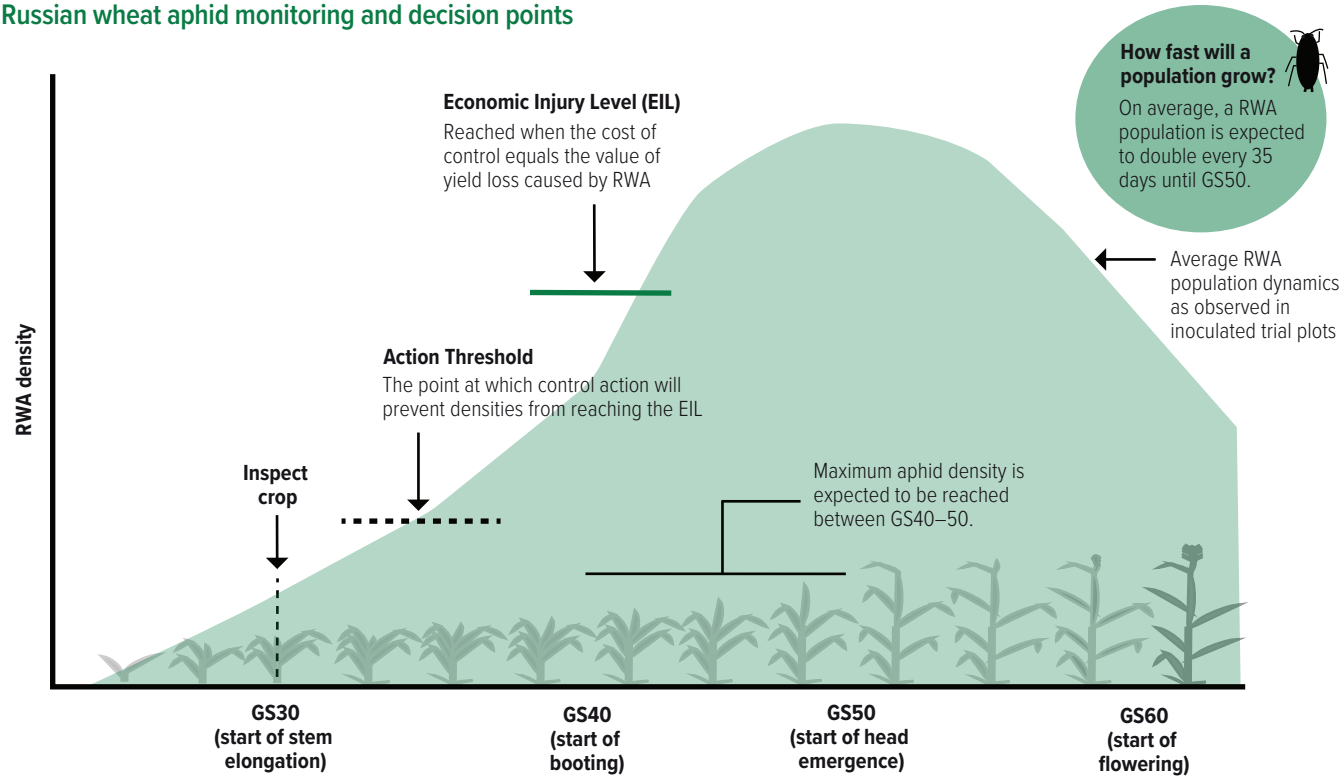
A control decision should be made based on RWA population densities at GS30. To determine if an RWA infestation in your crop is likely to surpass the EIL, use the online RWA Threshold Calculator, developed for Australian grain growing regions.

The calculator, and instructions for its use, are available on the GRDC website (see Useful Resources section).

Use a standardised monitoring procedure

To make an informed management decision, RWA density in the crop should be determined through monitoring at around GS30 (end of tillering). This is achieved by:

Russian wheat aphid monitoring and decision points



1 Counting the number of tillers in 50cm row lengths (choose at least five areas of the paddock, using the 'W' shaped search pattern to ensure good coverage of the paddock).

2 In the same row lengths counting the number of tillers with symptoms (to determine the *percentage of tillers with symptoms*).

3 In or around each of the five areas, check 20 of the tillers that have symptoms for the presence of RWA. The number of these 100 tillers that host RWA is the *percentage of symptomatic tillers with RWA*.

4 Multiply the *percentage of tillers with symptoms with the percentage of symptomatic tillers with RWA*. This will result in the *percentage of tillers with RWA*, which can be entered into the RWA GS30 Threshold Calculator.

Prevailing environmental conditions should also be considered. Rainfall and drying winds can kill RWA outside the shelter of leaf rolls, with heavy rain events sometimes killing 50% of the aphid population. Current registrations for control of RWA can be searched on the PubCris database, found on the Australian Pesticides and Veterinary Medicine Authority website at **apvma.gov.au**

Enact an integrated management strategy

Understanding green bridge risk, taking steps to control the green bridge, promoting natural enemies, and considering cultural controls will be integral to the long-term management of RWA.

1 Manage the 'green bridge'

Many weedy grasses and pastures can host RWA. Popular alternate hosts outside of the winter cropping window include barley grass, some *Bromus* (including prairie grass) species and *Phalaris* species, as well as volunteer cereals. Remove all volunteer cereals and grasses from the paddock, either by spraying, cultivating or heavy grazing at least four weeks before the next crop is sown.

2 Promote natural enemies

A diverse range of beneficial natural enemy species are known to predate on RWA. Surveying by Australian researchers has found that generalist predators are present near RWA populations year-round. Common generalist predators include spiders, lacewings (green and brown) and ladybirds, which have been found at their highest numbers in the spring and to a lesser degree in the autumn (generally corresponding with the extent of RWA presence).

Activity of specialised parasitoid wasps (indicated by the presence of mummified aphids) has also been found to be highest in spring, although some activity has been observed in the autumn as well, particularly in areas where there is an early build-up of aphid populations. Beneficial population growth tends to lag behind the aphid population growth. If RWA is observed, keep an eye out for generalist predators moving into the area or an increase in mummified aphids as a sign of parasitism.

Regional climate conditions can also indicate if other natural enemies, such as fungal pathogens, are likely to play a role in aphid control. Entomopathogenic fungi were favoured by high rainfall during the 2016 growing season and seemed to play a substantial role in the unexpected and sharp decline of RWA populations in the spring of that year.

The presence (and activity) of beneficials should be weighed up when determining the most appropriate management option, specifically in relation to insecticide timing and choice (selective chemistry vs broad spectrum activity). Many of these species are likely to be most abundant in cereals in spring.

3 Consider planting timing and location

If there are large areas of alternative hosts nearby (such as pastures), consider planting crops away from them to reduce the risk of infestation.

Planting earlier does not necessarily increase RWA risk but can often increase the risk of frost damage as plants will be too advanced when frost is still around. Extremely late plantings (June/July) are also at higher risk from spring colonisation during sensitive growth stages.

4 Apply chemical control according to the action threshold

Do not spray unnecessarily – only spray when the action threshold is reached. Prophylactic sprays for managing invading or dispersing RWA are ineffective in providing protection. These sprays will be detrimental to natural enemies and may create secondary outbreaks of other pests or may increase the likelihood of insecticide resistance evolving in other species.

WHAT TYPES OF NATURAL ENEMIES CAN YOU EXPECT TO SEE?

Beneficials species that attack RWA include those that commonly attack other cereal aphid species in the Australian environment, such as:

- Minute parasitoid wasps (*Aphidius colemani, A. platensis, Diaeretiella rapae, Aphelinus asychis, A. varipes*)
- Generalist predators including adult and juvenile ladybird beetles (*Coccinella* spp., *Hippodamia* spp.), juvenile green and brown lacewings (*Mallada* and *Micromus* spp.), damsel bugs (*Nabis* spp.), hoverfly larvae (*Syrphidae*) and earwigs (*Dermaptera*)
- Entomo-pathogenic (beneficial) fungi.

Photo: Elia Pirtle, Cesar Australia

Lacewing larva predating on RWA.

Photo: Elia Pirtle, Cesar Australia

Ladybirds are a common predator of RWA.

CONSIDERATIONS WHEN TAKING CHEMICAL CONTROL ACTION

- Yield loss by RWA is due to high populations building up in spring, which allows time to observe and decide for the need of a control action based on GS30 observations.
- If spraying is warranted, based on monitoring results, use selective chemistry where possible to preserve natural predators and beneficial insects, especially early in the season.
- The length of protection against RWA provided by seed treatments is similar to that observed for other cereal aphid species. However, prophylactic use of neonicotinoid seed treatments is discouraged. GRDC invested research has shown that even when RWA is consistently present in the environment, it rarely results in high infestations in autumn-sown cereal crops.
- Therefore, the use of insecticide seed treatment against RWA does not appear to be a cost-effective option and adds to the risk of insecticide resistance emerging in pest species.
- Seed treatment usage should be targeted at those situations deemed to be of higher risk (e.g. early sowing; proximity to RWA over-summer refuges; areas where volunteer cereals and/or live aphids are identified prior to sowing; areas where high populations of grasses frequently persist over summer through irrigation).

Ecology and impact

WHAT ARE THE PREFERRED HOSTS?

The host range of RWA includes more than 140 species of cultivated and wild grasses. RWA can develop to damaging levels in wheat and barley. RWA can occur in other cereals and cause some symptoms but no yield losses have been reported.

Non-crop hosts include barley grass (*Hordeum* sp.), which is highly preferred, prairie grass, great brome, soft brome, and volunteer cereals (regrowth from hay cuts and spilt grain volunteers).

Russian wheat aphid on non-crop hosts

Photos: Elia Pirtle, Cesar Australia


Barley grass


Prarie grass


Phalaris grass


Wild oat


Brome grass


Rye grass

WHAT ROLE DOES THE GREEN BRIDGE PLAY IN RWA SURVIVAL?

Like most other introduced aphid pests in Australia, invasive populations of RWA reproduce asexually with females giving birth to live female offspring. After their fourth moult, nymphs develop into either wingless or winged adults.

The primary mode of aphid dispersal is by winged individuals, carried on prevailing winds and on live plant material. Unwinged RWA can also migrate short distances to nearby host plants.

Conditions across the previous growing season and the intervening summer are influential in determining risk of aphid establishment at crop emergence.

Requirements for RWA infestation of autumn emerging crops are:

1. *Successful migration* of aphid in the previous spring onto appropriate hosts for the summer period;
2. Conditions supporting *aphid survival through the summer* in sufficient numbers to migrate; and
3. Conditions supporting *migration into emerging crops* in the autumn.

Low numbers of RWA migrate in autumn (March-April) and are attracted into emerging and young crops. These early colonisers will stay in the crop over the winter and build up in the warmer spring. After GS30 the percentage of infested tillers generally doubles every five weeks. The maximum percentage of tillers with RWA is usually reached between GS40 (start of booting) and GS50 (start of head emergence). This is the case for all cereals susceptible to RWA.

With the onset of warmer weather during spring, RWA populations build-up and become crowded, and plant nutrients become less available. This activates development of winged RWA (alates), which migrate to alternative green bridge hosts, including volunteer cereals and warm-season grasses. In order for winged RWA to migrate, temperatures need be high (20-25 degrees) and wind speed must be low.

Spring migration to alternative green bridge hosts covers 3–4 months from August to November. At later stages of growth (post GS50 – start of head emergence), cereal crops are unlikely to attract these migratory aphids. In the unlikely event that infestation does occur at an advanced growth stage (>GS 40 – start of booting), impact on yield is highly unlikely. Winged aphids are more likely to seek out actively growing alternative hosts.

Persistence of RWA over the green bridge is associated with moderate mean temperatures (<20°C) and low-moderate available soil moisture (5% in top 0–10cm). Migration occurs when daily maximum temperatures exceed 24°C. Hot and dry summer conditions will reduce over-summering populations of the aphid, with RWA likely to persist where there is available moisture and green material (from rainfall or irrigation). The presence of irrigated crops increases the likelihood of RWA survival.

WHAT YIELD LOSSES CAN OCCUR?

Yield loss is caused mainly by high populations developing between GS40 (start of booting) and GS50 (start of head emergence).

Within Australia, research has shown that the best metric for predicting yield loss is percentage of tillers with RWA. On average, for each per cent of tillers with RWA there is 0.28% yield loss predicted.

Use of the RWA Threshold Calculator is recommended for a more context-specific estimate. The plant growth stage at which RWA establishes has a strong effect on yield loss potential. If establishment occurs after GS30 there is low aphid growth potential. Even when aphid establishment occurs at early growth stages, large yield losses can be mitigated through monitoring and timely control.

IN WHAT REGIONS AND CLIMATES CAN IT SURVIVE?

Russian wheat aphid is able to thrive at a range of temperatures, surviving down to as low as -37°C and as high as 45°C. However, development and reproductive rates are most prolific between 2°C and 25°C.

In a study by Avila et al. (2019) the potential spread and establishment of RWA in Australasia was assessed using a re-parameterised CLIMEX model that took into account currently known distribution records of the aphid and the presence of irrigated crops. According to the model results, RWA has the potential to establish in all key grain growing regions in Australia. The aphid has been detected in South Australia, Victoria, New South Wales, Tasmania and Western Australia. Growers and advisers in all cereal growing areas nationally are encouraged to closely monitor their crops for signs of infestation and report detections in new regions to relevant government agencies. Good biosecurity practice is encouraged to minimise the risk of spreading the pest further.

RWA DISTRIBUTION IN AUSTRALIA

In areas where RWA is not known to occur reporting RWA assists with tracking changes in distribution. In areas where RWA is established correct identification will help you make informed management decisions.

Victoria: send photos or samples to Crop Health Services at AgriBio, 5 Ring Road, LaTrobe University, Bundoora 3083 or to PestFacts – southeastern (Cesar Australia) at 293 Royal Parade, Parkville 3051 (pestfacts@cesaraustralia.com).

South Australia: send photos or samples to PestFacts – South Australia, SARDI Entomology Unit, GPO Box 397, Adelaide 5001.

New South Wales: email biosecurity@dpi.nsw.gov.au

Tasmania: email plantdiagnosticservices@dpipwe.tas.gov.au

Queensland: call Biosecurity Queensland on 13 25 23 or email plantpestdiagnostics@daf. qld.gov.au

Western Australia: rsend photos through the PestFax Reporter app or email them to Pestfax@dpird.wa.gov.au

In areas where RWA is not known to occur you can call the Emergency Plant Pest Hotline (1800 084 881), which will direct you to your relevant state department.

USEFUL RESOURCES

Beneficial Insects – The Back Pocket Guide (Southern and Western Regions), www.grdc.com.au/BPG-BeneficialInsectsSW

Beneficials – Predators, parasitoids and pathogens: The Back Pocket Guide (Northern Region), https://grdc.com.au/BPG-BeneficialInsects-North

Cesar Australia (PestFacts) and SARDI PestNote (2019)
https://cesaraustralia.com/pestnotes/aphids/russian-wheat-aphid/
https://cesaraustralia.com/pestfacts/

GRDC RWA information page
https://grdc.com.au/resources-and-publications/resources/russian-wheat-aphid

PestFacts Reporter app
https://www.agric.wa.gov.au/apps/pestfacts-victoria-and-new-south-wales

PestsFacts South Australia newsletter
https://pir.sa.gov.au/research/services/reports_and_newsletters/pestfacts_newsletter

PestBites (2019) Russian wheat aphid identification video
https://www.youtube.com/cesaraustralia

Integrated pest management and pest suppressive landscapes with Phil Bowden
https://youtu.be/xkknl35m3GY

iSPY: Insect Identification for Broadacre Crops and Pastures guide
https://grdc.com.au//I-SPY

REFERENCES

Avila, G., Davidson, M., Van Helden, M., and Fagan, L. (2019). The potential distribution of the Russian wheat aphid (*Diuraphis noxia*): An updated distribution model including irrigation improves model fit for predicting potential spread. *Bulletin of Entomological Research*, 109(1): 90–101.

Heddle, T., Van Helden, M., Nash, M., Muirhead, K. (2020). Parasitoid communities and interactions with *Diuraphis noxia* in Australian cereal production system. *BioControl*, 65(5): 571–582. DOI: 10.1007/s10526-020-10030-1

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GRDC RESEARCH CODE

UOA1805-018 Russian wheat aphid risk assessment and regional thresholds. This project investigated regional risk and management tactics for Russian wheat aphid (RWA). The project was led by the South Australian Research and Development Institute (SARDI) and undertaken in partnership with Cesar Australia from 2018 to 2020.

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