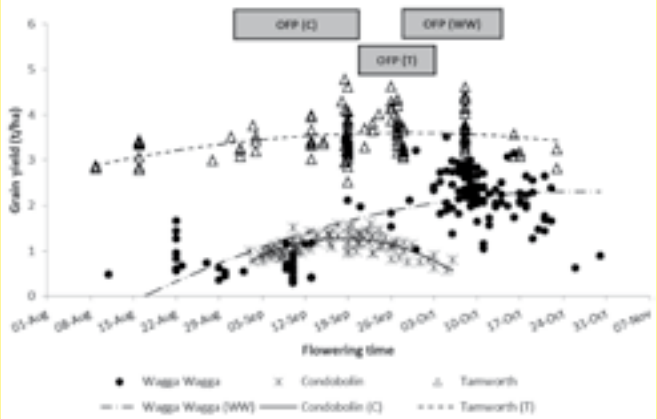
FIGURE 2: The relationship between flowering date and grain yield of genotypes with varied phenology patterns sown early April–late May at Wagga Wagga (WW), Condobolin (C) and Tamworth (T) in 2018



Shaded bars (e.g. OFP (C) for Condobolin) indicate APSIM simulated Optimal Flowering Period (OFP) for the three sites.

and were better able to utilise late October rainfall. Whilst slow-mid winter type DS Bennett flowered too late for the earlier OFP of Condobolin.

In contrast, despite the lack of rainfall early in the growing season at Tamworth, highest yields were achieved by winter and slow spring types sown April–early May which were able to utilise August–October rainfall (Figure 2).

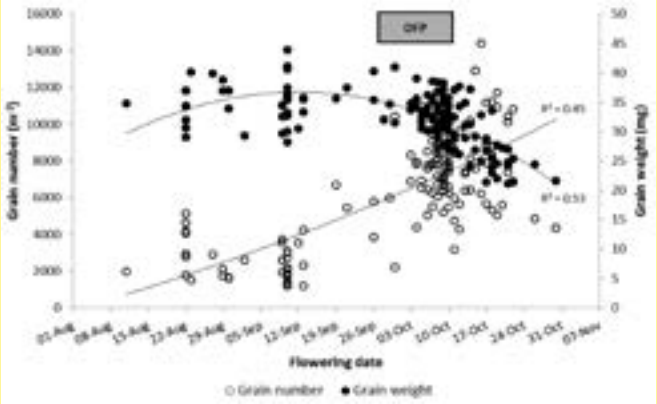
Timing of stress and yield development

The timing and duration of specific development phases are directly related to the formation of the key grain yield components – grain number (per unit of area) and individual grain weight. During the vegetative phase, leaves and tillers are formed prior to the transition into the reproductive phase, which coincides with the start of spikelet development.

Spikelet primordia continue to be initiated until early stem elongation. From here until flowering, rapid growth (accumulation of biomass), spike growth and differentiation occur, thus maximum grain number is determined during this

The most critical wheat growth stage for yield determination is from early stem elongation through to flowering.

FIGURE 3: Relationship between flowering date with grain number and grain weight for genotypes with varied phenology patterns sown early April-late May at Wagga Wagga in 2018

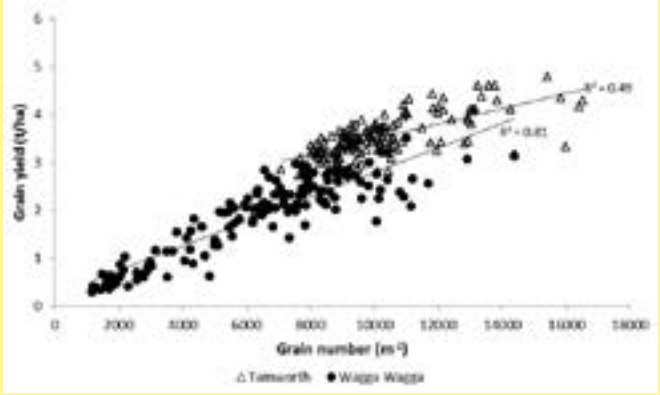


Shaded bar indicates APSIM simulated Optimal Flowering Period (OFP) for Wagga Wagga site.

time. This phase is known to be the critical period for yield determination, and as such, grain yield is very sensitive to stress, and any limitation to the crop at this time results in reduction in grain number.

After flowering, and during the grain-filling phase, the embryo develops, producing viable seed for the subsequent generation, this phase coincides with the establishment of grain weight.

FIGURE 4: Relationship between grain yield and grain number for genotypes with varied phenology patterns sown early April-late May at Wagga Wagga and Tamworth in 2018



The extent to which timing of stress events influences yield formation is highlighted in Figure 3, which illustrates the relationship between flowering time with grain number and grain weight at the Wagga Wagga site in 2018. Treatments which flowered earlier than the OFP, and were exposed to frost events, had reduced grain number, whilst treatments which flowered later than the OFP, and were exposed to heat and moisture stress during grain filling, had lower grain weights.

Despite the critical importance of the timing of stress events with corresponding yield components, grain yield has been more closely associated with grain number than grain weight in cereals, and this relationship has been maintained in environments characteristic of terminal drought or in low yielding seasons such as 2018 (Figure 4).

To sum up

We determined that the OFP, and the genotype x sowing date combinations which achieved the OFP and maximum yield varied between the locations. Variation across the sites was largely attributed to seasonal water supply and demand, and temperature extremes. The relationship between grain yield with grain number and grain weight indicated that yield losses are directly associated with timing of stress.

But even under the severe drought conditions in 2018, grain yield was primarily associated with grain number, reaffirming that the critical period for yield determination in wheat is from early stem elongation until flowering.

[1]NSW Department of Primary Industries, Wagga Wagga.
[2]NSW Department of Primary Industries, Tamworth.
[3]NSW Department of Primary Industries, Condobolin.
[4]NSW Department of Primary Industries, Trangie.
[5]NSW Department of Primary Industries, Orange.

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Step up Russian wheat aphid monitoring

GRAIN growers in southern and northern cropping regions are advised to keep an eye on their crops over the coming weeks as warmer spring conditions may promote flights of Russian wheat aphid (RWA).

RWA numbers have been minimal so far this season, due largely to low survival rates over the hot and dry 2018–19 summer.

Higher temperatures in spring may lead to an increase in aphid migration, but scientists say crops older than growth stage (GS) 40 do not appear to be attractive to migrating RWA, therefore colonisation of such advanced crops during spring is unlikely.

Rare cases of RWA presence and symptoms, below intervention thresholds, have been reported this year by growers and advisers in areas such as Victoria's southern Mallee and East Gippsland, as well as the New South Wales Riverina, Central West Slopes and Plains, and the Central Tablelands.

Entomologists involved in GRDC research investments say economically significant yield impacts are more likely from infestations that occur before stem elongation, but only if these persist during the later (heading and flowering) stages.

Maarten van Helden, an entomologist with the South Australian Research and Development Institute (SARDI) – the research division of Primary Industries and Regions SA – says detecting RWA in crops is not difficult as indications of infestation are usually quite obvious.

"A tell-tale sign is white or purple leaf streaking in cereal crops," says Maarten. "And at late tillering and during stem elongation, leaf rolling may occur."

Growers should search for the presence of aphids by peeling back rolled leaves, since symptomatic tillers do not always contain aphids and therefore treatment may not be required if the aphids have either moved on or died.

First identified in Australia in 2016, RWA is now present in many cropping areas of SA, Victoria, Tasmania and NSW. The aphid has not been detected in Western Australia, the Northern Territory and Queensland.

RWA expected to move north

RWA distribution is expected to move northwards again this year to northern NSW and possibly southern Queensland.

Since RWA has only been confirmed in Australia in recent years, limited research under local agro-climatic conditions and farming systems has been conducted. As such, a GRDC investment – 'Russian wheat aphid risk assessment and regional thresholds' – has been established to investigate regional risk and management tactics for RWA.

The collaborative investment is being led by SARDI, which is conducting research in partnership with sustainable agriculture research organisation cesar. Operation of field trials also involves a number of farming systems groups.

SARDI entomologist Dr Maarten van Helden features in a new GRDC podcast, discussing a GRDC research investment to determine economic thresholds to guide Australian growers in effective management of Russian wheat aphid. (PHOTO: GRDC)

The GRDC investment is investigating how RWA survives between winter cropping seasons. This knowledge is considered pivotal in determining the risk of infestation and potential damage ahead of each new cropping season, as well as aiding RWA management planning and development of cultural controls.

It is also seeking to determine the regional production risk posed by RWA and the economic thresholds that will guide growers in effective management of RWA, taking into account growing regions, crop varieties and climatic conditions.

This work is discussed in a new GRDC podcast (*http://bit.ly/2TxL2T7*) which features Maarten outlining research efforts to provide Australian growers with guidance about if and when to action chemical control measures in order to avoid significant yield loss, and – conversely – to avoid time and money being wasted on unnecessary treatments, especially if sufficient predatory insect populations are present to act as a biological control.

Economic thresholds

"When the aphid was introduced into the US in the 1980s, the Americans developed economic thresholds and so we are determining whether those same thresholds are valid in Australia," Maarten says. "Current threshold recommendations for chemical control, based on US research, are more than 20 per cent of seedlings infested with aphids up to the start of tillering and 10 per cent of tillers infested thereafter."

Trial sites have been set up in SA, Victoria, Tasmania and NSW to determine scientifically robust thresholds under varying Australian conditions.

Maarten says trials so far have shown that a considerable amount of RWA population pressure is required before yield loss is incurred.

"Overall, yield loss in our trials has not been as high as expected when aphid numbers have largely been above the overseas' threshold. It seems that the overseas thresholds are, at this stage, acceptable for affected Australian grain growing regions.

"Be aware that RWA seems to develop better on stressed plants so in very dry conditions the risks may be somewhat higher."

The current research effort builds on previous GRDC investments conducted by SARDI and cesar which focused on seasonal factors influencing RWA population growth, biotype confirmation, varietal susceptibility, damage and yield loss, and chemical efficacy.

Research will culminate with an update of the GRDC RWA Tips & Tactics guide, which can be found at *https://grdc.com.au/TT-RWA*. Growers and advisers will also have the opportunity to keep up to date with the research through fact sheets, research updates, newsletters, webinars and trial site visits.

In the meantime, further information on RWA management is contained in the Russian Wheat Aphid: Tactics for Future Control publication, available at https://grdc.com.au/rwa-tacticsfuturecontrol, as well as I SPY, a comprehensive crop insect identification manual, which can be viewed at *https://grdc.com.au/I-SPY*.

A RWA resource portal (including a constantly updated aphid distribution map) hosted by cesar is available at *http://bit.ly/2Px67tu*. A cesar-produced Pest Bites video on identification of RWA can be viewed via *http://bit.ly/2N7uwIG*.

Growers and advisers are encouraged to report occurrences of RWA in known areas of distribution to the GRDC's PestFacts services (*http://bit.ly/2O3hoBj for south-eastern, and http://bit.ly/2O35bMX* for SA) and the Beatsheet (*https://thebeatsheet.com.au/*) for the northern grains industry.

Suspected infestations in previously unaffected regions should be reported to the Exotic Plant Pest Hotline on 1800 084 881.

Growers can take advantage of pest identification services provided by cesar and SARDI through the National Pest Information Service. ■

Maarten van Helden shows plants with typical symptoms of Russian wheat aphid infestation, such as leaf streaking. (PHOTO: GRDC)