Turnip yellows virus epidemic in 2018 – time to get one step ahead of the green peach aphid

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Key messages

- In 2018, severe *Turnip yellows virus* (TuYV) epidemics in pre-flowering canola crops were caused by early green-peach aphid (GPA) incursions and infestation. Such epidemics are likely to become more frequent due to earlier sowing times, high susceptibility of current commercial varieties, and variable efficacy of neonicotinoid seed dressing.
- For such epidemics, an early warning system was developed using an innovative molecular diagnostic protocol to detect TuYV in migrating aphids caught on sticky traps. This provides TuYV detection before it reaches high incidences in the crop allowing growers to make targeted applications of systemic insecticide (e.g. sulfoxaflor) to give effective green peach aphid control thereby preventing epidemics and subsequent seed yield and quality losses.
- In 2019, DPIRD will supply yellow sticky traps prior to the growing season and offer free testing to interested agronomists and growers, whilst continuing surveillance at various south-coast locations.

Background

In 2018, severe TuYV epidemics in pre-flowering canola crops, predominantly in the Esperance port zone, were caused by early and widespread green-peach aphid (GPA) colonisation. When crops are infected early, seed yield losses of >40%, decreases in oil content, and increases in erucic acid and glucosinolate contents can occur (Jones et al. 2007). Recent research conducted in GRDC project DAN00202 demonstrated that most commercial canola varieties are highly susceptible to TuYV infection and significant yield loss (30-40%) can still occur around the beginning of bolting (GS30). Previous research has suggested that yield losses are negligible from infection at post-bolting growth stages. GPA is the principal TuYV vector to canola due to its high transmission efficiency, cosmopolitan nature, generally early arrival and rapid movement through crops. Furthermore, GPA has resistance to more insecticide chemistries than any other insect in the world. In Australia, GPA populations are resistant to synthetic pyrethroids, organophosphates and carbamates, whilst metabolic resistance to neonicotinoids has recently been identified (de Little et al. 2017). During the non-cropping period, TuYV and GPA survive in green-bridge volunteer or weed host plants, most importantly volunteer canola and wild radish. Canola growing areas are at higher risk when a significant green-bridge develops following significant summer and early-autumn rainfall events. Although severe TuYV epidemics have occurred in previous growing seasons, they are likely to become more frequent due to early sowing (exposing young plants to autumn aphid flights), high susceptibility of commercial varieties, and potential reduction of efficacy duration of neonicotinoid seed dressing due to metabolic resistance. Therefore, effective use of post-sowing control is crucial to preventing epidemics. Currently, the only effective post-sowing control option for TuYV control is application of systemic insecticides, which eliminate early GPA colonisation and protect crops from re-colonisation and therefore widespread TuYV infection. Sulfoxaflor (group 4C sulfoxamines - Transform™) is the only insecticide with systemic (also contact and translaminar) action registered for foliar application effective for GPA control; therefore, it needs to be used judiciously.

In 2017, DPIRD's flagship project FFPjP06 developed a loop-mediated isothermal amplification (LAMP) protocol to detect TuYV in aphids amongst large numbers of non-viruliferous aphids from various types of insect traps (Congdon et al. 2019). This could allow TuYV detection prior to establishment in the crop and a decisive sulfoxaflor application to prevent an epidemic and subsequent seed yield and quality losses. The following paper presents research from DPIRD's flagship project FFPjP06 on use of the LAMP protocol to develop and validate a TuYV epidemic early warning system to detect TuYV in winged aphids migrating into canola crops caught on sticky traps before it spreads to high levels.

Method

In 2017 and 2018, two-faced yellow sticky traps were deployed on fencelines at 30 grainbelt farm sites sown to canola (see Figure 1). From 3 to 12 weeks prior to sowing (depending on the site) until approximately 50% podding (GS75), traps were deployed and collected every two weeks. At each site, three traps were tied to the top of the fence placed approximately 50 m apart from each other down the fenceline. All aphids caught on each trap face were counted, removed from the sticky traps and placed into a single small tube. A motorised polypropylene pellet pestle was used to grind aphids and the homogenate was tested for TuYV by LAMP.

To examine the relationship between TuYV detection in the aphids caught and TuYV spread in the crop, each canola crop was sampled from approximately the two-leaf stage (GS12), every two to six weeks until 50 to 100% podding (GS75-80) or when

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TuYV had reached 100% incidence in the crop. To do this, tip leaf samples of 200 plants were taken in a 'W' pattern from the fenceline at the first trap to ~80 m diagonally into the crop then diagonally back to the fenceline at the second trap, and so on. All leaf samples were tested individually or in groups of two to 10 by ELISA.

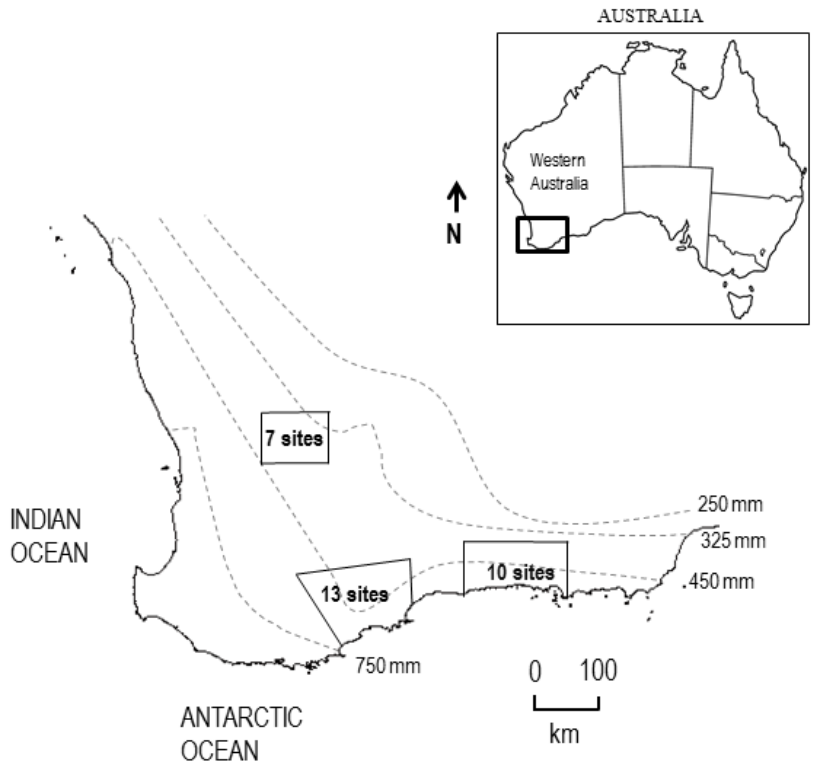

Figure 1. Map of Australia showing where the south-west Australian grain-growing region (grainbelt) is located. Insert shows the three general areas in which trap deployment sites were located and number of sites per area located in each.

Results

By collecting aphid trap and virus incidence data at 30 sites sown to canola in the south-west Australian grainbelt, we developed and validated a TuYV epidemic early warning system involving a LAMP protocol designed to detect TuYV in aphids. TuYV detection in winged aphids in a six-week period from approximately emergence until five leaf stage (GS15) was a strong predictor for subsequent virus spread in the crop (Figure 2). In all scenarios in which TuYV-carrying aphids were detected on >30% of trap faces in this six-week period, TuYV reached ≥60% crop incidence by GS30. Conversely, TuYV detection on ≤15% trap faces during this period was associated with ≤6% TuYV spread at GS30. Although the presence of aphids was a prerequisite for spread to occur, many scenarios occurred where there were significant aphid numbers on traps but none carrying TuYV, and therefore, subsequent negligible levels of TuYV spread by GS30.

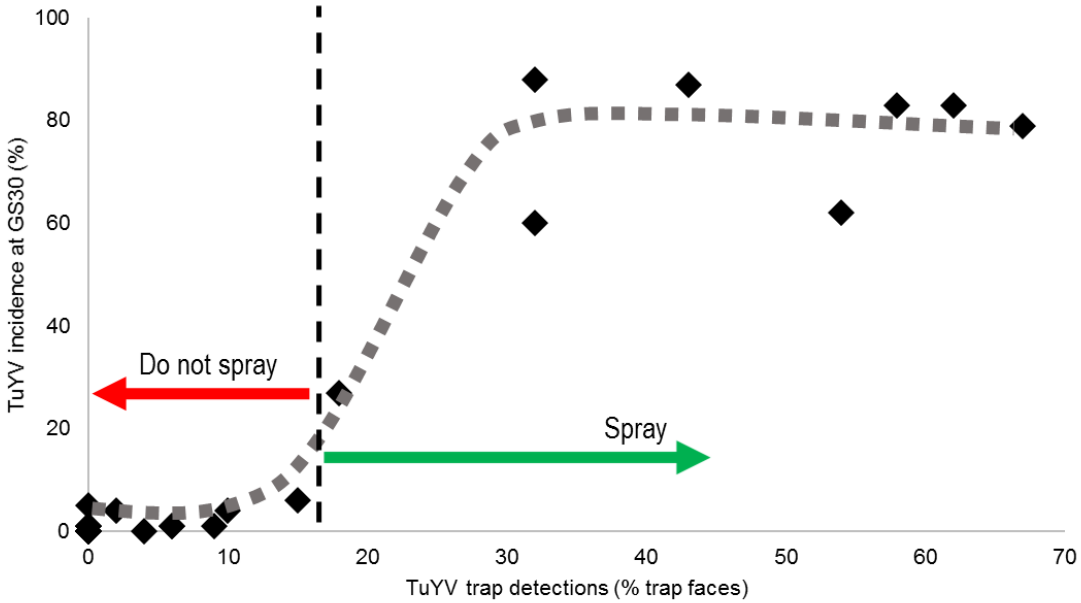

Figure 2. Relationship between *Turnip yellows virus* (TuYV) crop incidence at GS30 and detection of TuYV in aphids caught from pre-emergence until GS15, and its impact on spray decision at GS15.

To highlight the importance of detection of TuYV-carrying aphids during this critical six-week period, three examples are given below in Figure 3. In scenario **'A'**, winged aphids were caught during the critical period (pre-emergence until GS15) but were not carrying TuYV. Consequently, there was negligible virus spread in the canola crop by GS30 (5% plants infected). In scenario **'B'**, winged aphids were caught during the critical period and TuYV was regularly detected in them. Consequently, there was a severe TuYV epidemic in the crop by GS30 (>80% plants infected) and seed yield and quality losses would likely have been incurred. In scenario **'C'**, TuYV-carrying aphids were detected during a six-week period from pre-sowing until they disappeared just prior to crop emergence. At this site, germination was delayed due to very dry sowing conditions and migrant aphids had no crop to land on and colonise. Therefore, there was no spread by GS30.

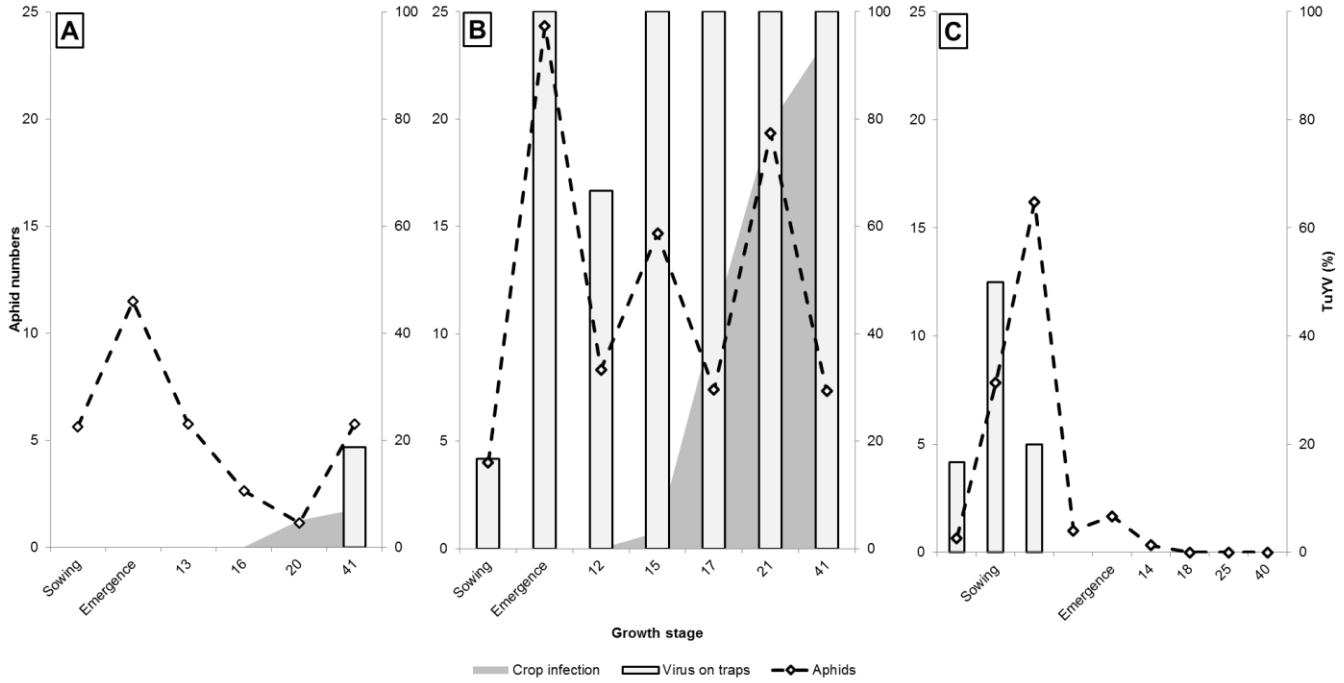

Figure 4. Aphid numbers (left y-axis), % of trap faces with *Turnip yellows virus*-carrying aphids (right y-axis) and % TuYV in crop over the critical period of the growing season at three sites: **A** – Coomalbidgup in 2017, **B** – Coomalbidgup in 2018 and **C** – Woogenellup in 2018.

Conclusion

The TuYV epidemic early warning system developed in this study will enable proactive TuYV management in regards to application of non-prophylactic, precisely timed and highly effective systemic insecticide (e.g. sulfoxaflor) applications. These will eliminate initial GPA crop colonisation, protect vulnerable plants from future infestations, and prevent epidemic level TuYV spread in vulnerable pre-GS30 canola crops and minimise subsequent seed yield and quality losses. In 2019, continued testing of smart traps in a trapping network currently being established will provide information on virus risk for some high-risk south-coast grainbelt locations in the Albany and Esperance port-zones. However, advisors operating in high-risk areas (high rainfall zones and/or areas developing a significant green-bridge) are urged to take advantage of this early warning system service by contacting DPIRD Diagnostic Laboratory Services (DDLS) to obtain yellow sticky traps that they can deploy on a fenceline of a paddock designated for canola and get tested by LAMP for free. To ensure optimal timing of a sulfoxaflor application throughout the critical early growth stages of the crop, traps should be deployed, collected and sent back to DDLS every two weeks from around crop germination until GS20.

For further information, DDLS can be contacted on **+61 (0)8 9368 3351** or by emailing **DDLS@dpird.wa.gov.au**.

Key words

Turnip yellows virus, green peach aphid, disease management, loop-mediated isothermal amplification

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