INVITED ARTICLE

BARLEY YELLOW DWARF: INCIDENCE AND NATURAL SPREAD IN WHEAT

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TAKE HOME MESSAGES

- An extremely high level of barley yellow dwarf disease was recorded in Victorian cereal crops in 2013; 40-70 per cent infection.
- A high number of aphids flying into crops from neighbouring vegetation reduced the effectiveness of the insecticides.
- Regular crop monitoring is essential to maximise yield while minimising the effects of aphids and BYD spread.

KEYWORDS

Aphids, barley yellow dwarf virus in wheat, barley yellow dwarf virus, BYD, BYDV, crop disease, crop pests, insecticides, PAV, RPV.

BACKGROUND

Barley yellow dwarf (BYD) is the most damaging viral disease of cereal crops throughout the world and in Australia (*D'Arcy and Burnett 1995*). This virus is only transmitted from infected to healthy plants by aphid vectors and it has been shown that 25 species of aphids can vector it (*Halbert and Voegtlin 1995*). Over 150 plant species within the Poacae family are characterised as hosts of BYD, including food crops such as wheat, barley, oats and corn (*Gould and Shaw 1983*). BYD has a negative effect on plant growth, as it decreases root biomass, diminishes plant vigour and greatly reduces grain yield and quality (*Irwin and Thresh 1990; McKirdy et. al, 2002*). The most common symptoms of BYD are plant stunting and leaf discoloration (either yellow or red) which starts from the tip of the leaf and spreads towards the base (Figure 1a). The severity of this disease largely depends on the inoculation time: plants are at their most vulnerable when they are infected in the early growth stage (*Freeman and Aftab 2011*). In addition, abiotic factors, including drought and heat, can intensify severity of this disease.

Figure 1a) Barley yellow dwarf infected wheat, visible symptoms of discoloration. Figure 1b) Colony of the bird cherry-oat aphid (*Rhopalosiphum padi*), the main vector of BYD disease and the most common aphid in wheat in Western Victoria.

In Victoria, the bird cherry-oat aphid (*Rhopalosiphum padi*) (Figure 1b) is the most common aphid species in wheat and is responsible for spreading BYD to cereal crops. However, despite its economic importance, little is known about its population dynamics, virus transmission efficiency and direct damage to wheat and other crops. In this study, we investigate the incidence of two strains of BYDV (PAV and RPV) in the field and examine the influence of BYDV PAV infected plots on the rate of infection of neighbouring plants.

AIM

To assess the natural incidence of two BYD strains (PAV and RPV) in an insecticide treated field and to evaluate the effects of disease 'hot spots' (infected plots with BYD) and infection rate on neighbouring plants.

METHOD

Location:	DEPI field site, Horsham, Victoria
Replicates:	13
Virus tested:	Barley yellow dwarf – PAV and RPV strains
Sowing date:	30 May
Virus inoculation date:	17 July
Target plant density:	150 plants/m^2
Crop type:	Yitpi wheat

Thirteen experimental plots (three rows by 50cm) were established and inoculated with BYDV PAV strain. This was accomplished by placing the second leaf of the plants main stem into a plastic tube containing 10-15 aphids which were infected with PAV. The opening of the tube was secured with cotton wool to prevent aphids from escaping. After 72 hours, tubes and aphids were removed and the plots were hand sprayed with contact and systemic insecticide. A few days later, the whole field was sprayed with the same insecticide to kill any aphids remaining after the initial inoculation.

In sampling for BYD virus, two plots at two distances (0.2-0.5m and 0.7-1m) from the control BYD virus inoculated plots were selected to assess the influence of our virus 'hot spots' on adjacent plants. Additional plots 10-15m away from the BYD inoculated plots were established as a control of natural virus infestation. Plants were confirmed to be infected with BYD virus using a tissue-blot immunoassay

(TBIA) a widely used serological test for plant viruses (*Freeman et al 2013*). Five plants per BYD control plots and ten per non-inoculated plots were tested for BYD PAV virus. Additionally, ten plants from three non-inoculated plots were tested for the RPV strain of BYD virus.

Summary statistics analyses was performed in Microsoft Excel. Statistical testing, t-test and analysis of variance were performed in R statistical software. Graphs were completed in SigmaPlot.

RESULTS AND INTERPRETATION

In 2013, an extremely high level of BYDV was recorded in wheat crops in western Victoria. Surveys of selected wheat plots in the Horsham area showed up to 70 per cent virus infection in certain cultivars (data not included). This exceptionally high incidence level of BYD disease might be explained by favourable climatic conditions for the bird cherry-oat aphid – the species that transmits this virus. This aphid, the most common sap-sucking pest of cereal crops in Victoria and the main vector for both BYD strains (PAV and RPV) tested in this study, prefers cooler and wetter weather conditions. A peak in aphid population was recorded in mid-August and exceptionally high numbers of aphids were present in the field until the end of September.

Despite insecticide use, the control BYD PAV infected plots had a significant effect on virus incidence in adjacent plants. Plots 0.2-0.5m away from the BYD control plot had over 18% higher incidence of BYD PAV. In this instance, the critical distance for secondary BYD PAV infection was 0.5m and was statistically significant at P=0.010. Infection rates in the second and third plots, 0.7-1m and 10-15m respectively distant from the control plots, were similar. (Figure 2, BYD PAV). However, these infection rates were not statistically significant (P=0.678).

RPV, another strain of BYD, can exist but be less prevalent than PAV. The same uninfected plants screened for PAV were also tested for BYD RPV during a second assessment. As we did not artificially introduce BYD RPV infection into the control plots, there was no significant difference in the percentage of RPV infection (P=0.181) between the three plots tested.

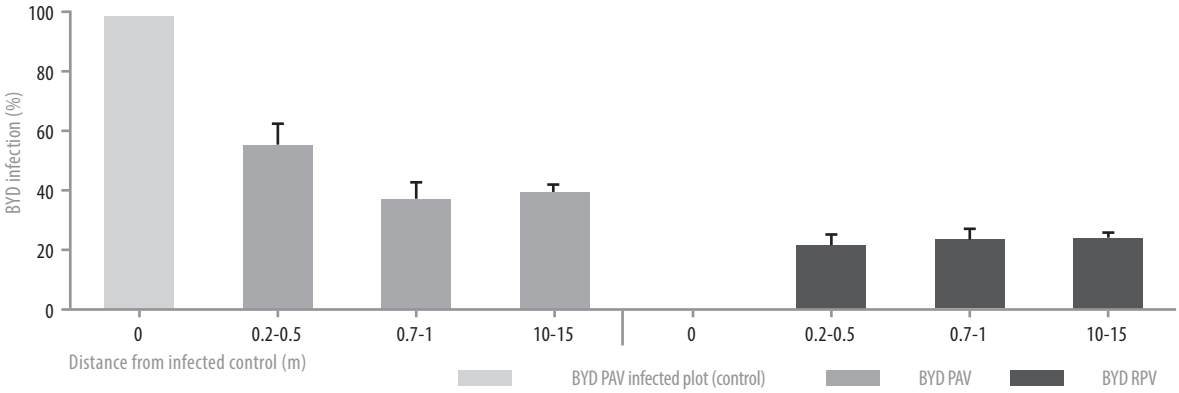

Figure 2. BYDV incidence in plots at three distances from the control inoculated BYD PAV plots. Left graph: BYD PAV; right BYD RPV virus strain. No test for RPV virus was done in BYDV PAV control plots.

To analyse the difference in the natural incidence of BYD between PAV and RPV strains, two plots 0.7-1m and 10-15m away from the BYD PAV 'hot spot') were combined due to no significant difference between them for each virus strain (PAV P=0.678; RPV P=0.772). As expected, PAV strain was dominant: its incidence in the field was 15% higher than RPV. This was significant at P=0.003 (Figure 3).

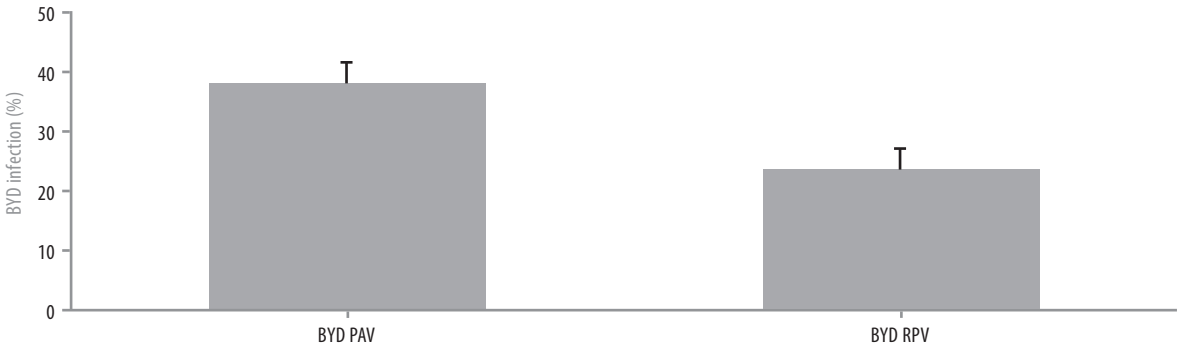

Figure 3. Percentage of natural infection rate between two BYD strains, PAV and RPV.

COMMERCIAL PRACTICE

Regular crop monitoring is essential to maximise the yield while minimising the effects of pests and diseases. Although some aphid resistance to insecticide application was recorded in other studies, chemical control is a major option for the reduction of vectors and subsequently disease outbreaks transmitted by insects.

Despite insecticide application, in this study, a high level of barley yellow dwarf infection, as well as aphid activity, was recorded. The effects of the insecticide application rate and frequency on BYD disease spread is poorly understood and highly complex. After arriving into the sprayed crop, virus-infected aphids initiate feeding during which the virus is transmitted. It takes eight to 12 hours for the aphid to acquire the virus and transmit it to another plant. The effectiveness of the insecticide depends not only on preventing aphids from continued sustained feeding, but minimising the timing of feeding and virus transition. In the case of BYD disease, which is phloem transmitted, aphids often transmit the virus before the desired insecticide effect takes place, reducing the aphid numbers, but not necessarily preventing the disease.

To protect the crop from BYDV, this preliminary work highlights the importance and need for crop monitoring and adjusting the timing of chemical usage to coincide with high aphid activity. Further research is critical for greater understanding of the effects of insecticides and virus transmission/ acquisition and for reducing the severity and incidence of the disease.

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