Pea seed-borne mosaic virus: occurrence and management in field pea crops in Western Australia

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Key messages

- Most field pea growers in the Esperance region are aware of *Pea seed-borne mosaic virus* (PSbMV) infection in their crops but do not rate it as a priority. In 2015, PSbMV was detected in 10/14 field pea crops in this region. In 2013-2015, it was found in 20/24 field pea cultivar test plots located in Bolgart, Muresk and Grass Patch. These findings suggest widespread PSbMV infection is present in commercial seed of a wide range of commonly sown cultivars.
- Six years of incidence and aphid data collected from field pea blocks at different locations in the wheatbelt suggest a strong relationship between autumn rainfall and subsequent PSbMV spread. This is due to its ability to drive early background aphid populations which subsequently visit young crops. Infection levels in seed sown were also of major importance in determining the amount of PSbMV spread, especially in high risk years.
- With assistance of a risk forecast, the negative impact of a high risk year can be mitigated by sending a representative seed sample for PSbMV testing to assess its infection levels. To avoid high yield losses, the recommendation is not to sow seed stocks unless sample test results are <0.5% in low risk zones or <0.1% in high risk zones. Alternatively, the resistant cultivar Wharton be utilised.

Aims

Field pea is an important crop legume for rotations with cereals in Western Australia (WA). It is particularly suited to finely textured neutral to alkaline soils to which lupins are poorly adapted. However, the area sown to field pea has decreased by approximately 65% since 2012 in WA, with the majority being grown in the Esperance region. This decrease is due to a combination of volatile prices, crop lodging at harvest and disease. The disease caused by *Pea seed-borne mosaic virus* (PSbMV) infection in field pea crops results in substantial seed quality and yield losses, especially when seed with >0.5% infection level is sown and PSbMV incidences are high early in the life of the subsequent crop. This paper describes: (i) incidence data from surveys in recent field pea crops and seed-lots around the Esperance and Avon regions; (ii) environmental factors, aphid numbers and PSbMV incidence data collected in field pea data collection blocks in multiple locations in the wheatbelt over a 5 year period and their use to develop a forecasting model; and (iii) assessment of PSbMV infection levels in small seed fractions to establish the potential of sieving as an indication of seed-lot infection level or as a method of reducing infection levels in seed-stocks.

Method

Incidence data – commercial field pea crops and cultivar trial plots

In 2015, 14 field pea crops were sampled at 6 sites in the Esperance growing region (Scaddan, Beaumont, North Cascade, Grass Patch, West Scaddan and Wittenoom Hills). For each crop, 100 samples were collected by taking a single shoot tip every 5 paces. Samples were collected in a 'V' shaped pattern starting 20 m within the perimeter of each crop. To attain a final PSbMV incidence value, sampling was done in late September (spring) when crops were podding and beginning to senesce. Leaf samples from cultivar trial plots were taken in 2013-2015 from Bolgart (2013 and 2014), Muresk (2015) and Grass Patch (2013-2015). Shoot tips of 100 field pea plants per cultivar were taken across 3-4 replicates of Cvs Kaspa, Twilight and Gunyah in 2013-2015, Cv. Wharton in 2014-2015, and Cvs Parafield, Percy, Oura and Bundi in 2013. All samples were PSbMV tested at the DAFWA plant virology laboratory.

Field pea data collection blocks

Large square data collection blocks of field pea were sown annually by DAFWA between 2010 and 2015 across 5 different sites in the Avon and Esperance regions of the south-west Australian wheatbelt (2–3 sites per year). The blocks were located at Muresk (2010, 2011 and 2015), York (2012), Bolgart (2013–2014), Wittenoom Hills (2010-2012) and Grass Patch (2010–2015). Two cultivars were used, Kaspa (2010-2015) and Twilight (2012-2015). The data collected in different years and sites represented a wide range of climatic scenarios, sowing dates, and PSbMV seed infection levels. Yellow sticky traps positioned on two opposite corners of a central 20 x 20 m square in each block were used in all years to monitor aphid movement. In 2014 and 2015, to collect intact aphids for species identification, plastic boxes containing a green tile were maintained at canopy height and half-filled with a solution containing a 30% dilution of polyethylene glycol in water. Sites were visited weekly to change aphid traps and fortnightly to collect 100 random shoot tip samples. At the end of the season, the blocks were harvested and 1000 seedlings grown from a representative seed sample tested for PSbMV transmission.

Seed sieving

500g seed samples from each of nine seed-lots of cultivars Kaspa, Twilight and Gunyah were sieved into three fractions; <6.0 mm, 6.0-6.5 mm and >6.5 mm. Seed was shaken in the sieve for 45 seconds each time. Then each fraction was weighed and sown into trays with potting mix. A maximum of 600 seedlings for each fraction were tested for PSbMV.

Results

Incidence data – commercial field pea crops and cultivar trial plots

There was a high frequency of PSbMV infection in field pea crops and cultivar trial plots; 10/14 field pea crops in 2015 having levels of 2-51% infection and 20/24 cultivar trial plots from 2013-2015 having levels of 0.1-100% infection. Out of the four field pea crops without infection, two were of the PSbMV-resistant Cv. Wharton and the other two were of Cv. Gunyah crops from Beaumont. All four of the cultivar trial plots without PSbMV infection were of Cv. Wharton. A Kaspa crop from Scaddan with 49% final incidence was originally sown with seed with 0.6% PSbMV infection whilst a Gunyah crop with 2% final incidence was sown with seed with levels of only 0.06% PSbMV infection. This highlights the importance of sowing healthy seed.

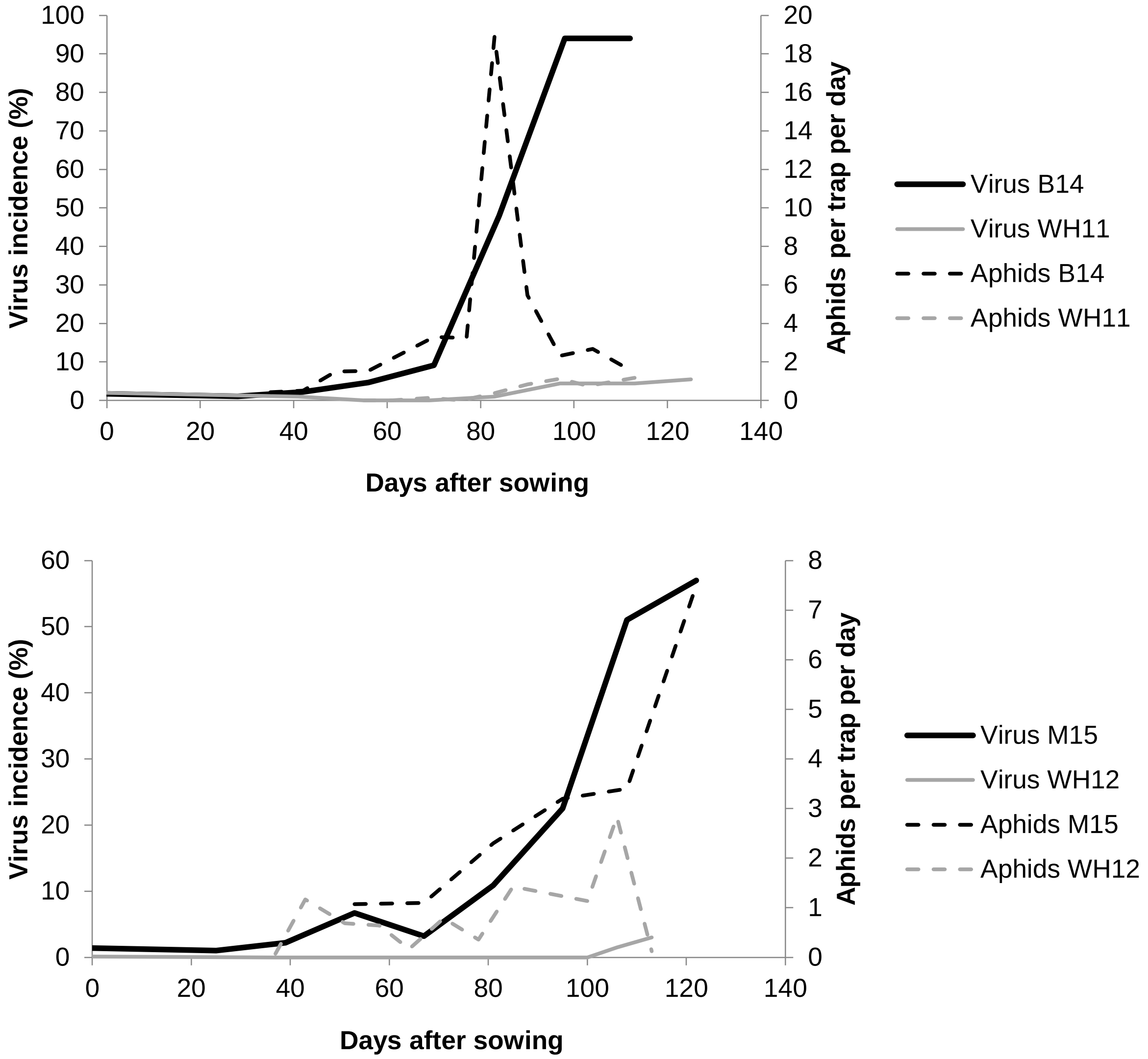

Fig. 1. Comparison of virus incidence and aphid trap counts in field pea Cv. Kaspa data collection blocks at Wittenoom Hills in 2011 and Bolgart in 2014, and in field pea Cv. Twilight data collection blocks at Muresk in 2015 and Wittenoom Hills in 2012[a,b].

[a] Sowing dates 30 May at Wittenoom Hills 2011, 11 June at Bolgart 2014, 29 May at Muresk 2015 and 10 June at Wittenoom Hills 2012.

[b] PSbMV infection in sown seed was 2% for Wittenoom Hills 2011, 1.7% for Bolgart 2014, 1.4% at Muresk 2015 and 0.1% at Wittenoom Hills 2012.

Field pea data collection blocks

Two comparisons are illustrated in Fig 1, Wittenoom Hills in 2011 (WH11) and Bolgart in 2014 (B14), and Wittenoom Hills in 2012 (WH12) and Muresk in 2015 (M15). WH11 received 48.2 mm of rainfall from March to May 2011. Relative aphid numbers (aphids per trap per day) were minimal until around 105 days after sowing (DAS) and reached 5.5 by 113 DAS. PSbMV incidence at flowering was 4% and final incidence was 5%. B14 received 134.2 mm of rainfall from March to May 2014. Relative aphid numbers reached 18.9 per trap per day 83 DAS. PSbMV incidence at flowering was 29% and final incidence was 94%. Seed transmission rates in harvested seed from the blocks were 2% in WH11 and 10% in B14. WH12 received 81.6 mm of rainfall from March to May 2012. Relative aphid numbers built up from 40 DAS to reach a peak of 3 per trap per day by 100 DAS. PSbMV incidence detected at flowering was 0% and final incidence was 3%. M15 received 83.2 mm of rainfall from March to May 2015. Relative aphid numbers built up from 50 DAS to reach a peak of 7 per trap per day by 120 DAS. PSbMV incidence detected at flowering was 22% and final incidence was 57%. Seed transmission rates in harvested seed from the blocks were 1% in WH12 and 4% in M15. Green-peach aphid (*Myzus persicae*) was found to be the most prominent aphid vector in each block containing a green tile trap.

Data from the blocks are currently being used to develop a forecasting model.

Seed sieving

In the 7/9 seed-lots tested, PSbMV infection was significantly higher in the <6.0 mm seed fraction than the >6.0 mm fraction (Fig. 2). The two exceptions were two Cv. Gunyah seed-lots that had minimal levels of infection (0.06-0.15%) in which only 1-2 infected seedlings were detected.

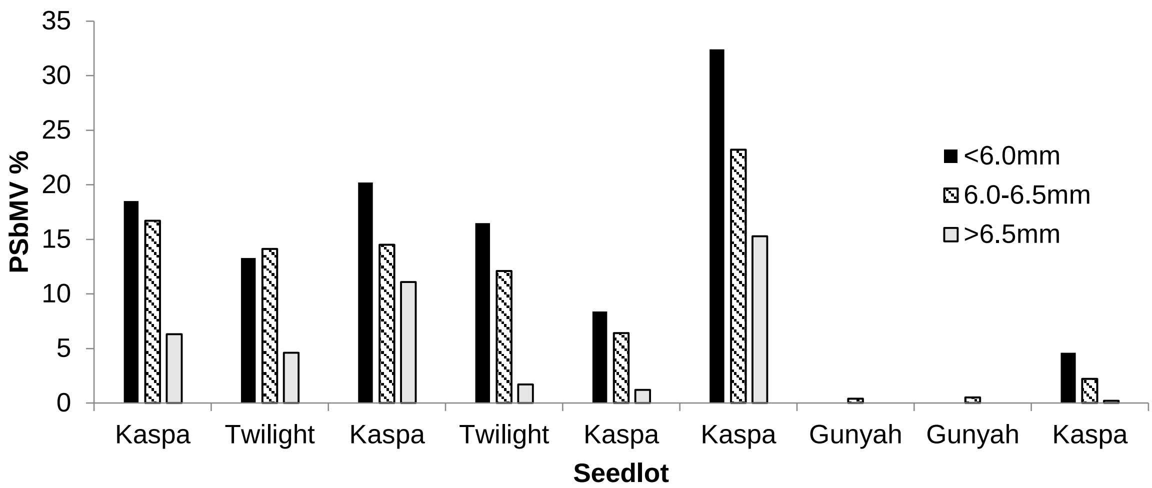

Fig. 2. PSbMV infection levels in three seed fractions (<6.0 mm, 6-6.5 mm and >6.5 mm) from nine different seed-lots[a]

[a] See Table 1 for seed-lot information.

Conclusion

PSbMV infection was widespread in commercial field pea seed-lots from the WA wheatbelt. Except with the PSbMV-resistant Cv. Wharton, infection was found in all commonly used cultivars in commercial crops in Scaddan, Grass Patch, Cascade, Muresk and Bolgart. PSbMV-resistant Cv. Wharton appears to be a reliable option to sow when seed infection levels are >0.5% and the risk of spread is high. However, in years of minimal PSbMV spread sowing low PSbMV content seed of other locally adapted and higher yielding cultivars such as Cvs Kaspa, Twilight and Gunyah may outperform Cv. Wharton. Therefore, to be able to make informed seed-lot selection decisions, it would be useful to have access to a forecast of PSbMV risk prior to sowing. This can be delivered together with the blackspot spore release forecast currently in use.

As suggested by the comparison between field pea data collection blocks WH11 and B14 in Fig. 1, the amount of autumn rainfall prior to sowing, provides a strong driving influence on aphid build-up and subsequent PSbMV spread in crops throughout the growing season. When conditions during this period are dry, aphids take much longer to build-up as surrounding vegetation is much less developed and unable to sustain high population numbers. This means there is very little PSbMV spread in the critical early phase of crop growth and so minimal yield and quality losses result. The comparison between M15 and WH12 also illustrates the critical importance of infection levels in the sown seed. Despite both blocks receiving the same amount of rainfall during the March-May period and subsequent aphid numbers being similar in the early part of the growing season, M15 had much more PSbMV spread throughout the growing season than WH12. The WH12 block had only very low levels (below the critical threshold) of PSbMV seed infection. Based on previous work (Coutts et al 2009, Phytopathology, volume 99), WH12 would have had no yield loss from PSbMV whilst M15 would most likely have had yield losses of up to 20%, which would constitute a large proportion of a grower's profit margin. Additionally, higher PSbMV incidences around the time of crop flowering resulted in far higher levels of infection in the harvested seed. Thus, this seed would be too high to sow in any year.

Climatic data from autumn, PSbMV incidence data around the time of flowering, subsequent yield loss, and seed transmission level data are being used to develop a PSbMV forecasting model. This tool will be extremely useful for growers as it will provide a PSbMV risk assessment prior to sowing. By providing a high risk year forecast before sowing time, growers will be able to obtain healthy seed or use Cv. Wharton in addition to implementing other PSbMV control strategies. When a low risk year is forecasted, growers can avoid wasting time and resources being over cautious and can use low PSbMV-content seed (<0.5% infection) of susceptible cultivars which may be better suited for the location.

Growers will be able to know the PSbMV infection levels in their seed-stocks by having a representative seed sample sent for testing. The process takes 2-3 weeks and costs approximately $550 per sample. However, this cost is greatly outweighed by the yield penalties associated with sowing a seed-lot with high infection levels in an epidemic year. A first port of call may be to sieve samples of a seed-lot using a 6.0 mm sieve to calculate the size of the small seed fraction (<6.0 mm) to provide an estimation of PSbMV infection. This would be most reliable with seed-stocks from crops that had good quality finishes as seed size is significantly influenced during this period of grain filling. Sieving of seed on a larger scale to remove the small seed fraction (<6.0 mm) may help reducing the levels of PSbMV below the critical threshold. The small seed fraction may then be used as livestock feed. However, seed-lots with high levels of infection may still have levels in the large seed fraction above the critical threshold of 0.1% in high risk scenarios.

Our economic analysis suggested that taking action based on having PSbMV forecasting model predictions could lead to field pea yield increases of 20% during epidemic conducive years with anticipated profit increases of $100/ha on average. Widespread optimal PSbMV management would generate increased grower confidence in growing field pea, thus leading to its increased adoption in the Esperance and Great Southern Regions. This potential increase does not include rotational benefits to cereal production via improved nitrogen fixation, greater weed control options and more effective disease breaks. Moreover, the reduction in PSbMV-induced discoloured seed delivered to market could lead to a decrease in pea seed export downgrades and further increase profits by $20/ha.

More information: https://www.agric.wa.gov.au/field-peas/pea-seed-borne-mosaic-virus-field-peas

For seed testing: AGWEST Plant Laboratories (08 9368 3721)

Key words

Field pea, *Pea seed-borne mosaic virus*, epidemiology, forecasting model

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