Canola concurrent session

Canola diseases – threats and management

Kurt Lindbeck¹, Stephen Marcroft² and Joop van Leur³

¹NSW - Department of Primary Industries, Wagga Wagga Agricultural Institute, Pine Gully Road, Wagga Wagga, NSW 2650; ²Marcroft Grains Pathology P/L, Grains Innovation Park, Horsham, Vic. 3400, Australia; ³NSW - Department of Primary Industries, Tamworth Agricultural Institute, Marsden Park Road, Calala, NSW 2340

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Canola, blackleg, sclerotinia, disease management

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Take home messages

1. Impacts on yield due to blackleg of canola are likely to be lower in northern NSW compared to southern NSW.

2. Growers should still be vigilant in managing this disease and an integrated approach should be adopted by growers that utilises cultivar resistance, cultural control and the strategic use of fungicides.

3. Sclerotinia stem rot will be a production issue where spring rainfall is adequate to provide long periods of leaf wetness in the presence of flowering canola crops.

4. If there is a history of sclerotinia stem rot in your district causing yield loss, be prepared to use a foliar fungicide to reduce yield loss.

5. The impact of powdery mildew on canola yields is largely unknown. Research will be conducted to investigate this issue in 2014.

Blackleg

Blackleg, caused by the pathogen Leptosphaeria maculans, is the most damaging disease of canola and juncea-canola in Australia. In southern NSW this disease is a major concern for producers, mainly due to the high intensity of canola production in the region. In northern NSW the level of blackleg observed in commercial crops has been significantly lower where production of the crop is not as concentrated.

Despite the lower levels of blackleg observed in the north growers and advisors should still be vigilant in the management of this disease. Blackleg is present in all canola paddocks and the experience from southern NSW showed higher levels of blackleg in canola crops with increasing intensity of production in the region.

How do we best manage blackleg?

The most effective approach to reduce the impact of blackleg is to use an integrated strategy that utilises cultivar resistance, cultural control and the strategic use of fungicides. The most effective management practices that can reduce the impact of blackleg include:

1. Sowing canola cultivars with appropriate levels of blackleg resistance. This is particularly important in districts with a high intensity of canola production where cultivars should be sown
with high levels of blackleg resistance. Plant resistance is the first line of defence against blackleg.

2. **Avoid canola stubble, especially from the previous season's crop.** The distance from last season’s canola stubble will largely determine the severity of blackleg in this season’s canola crop. Where possible a distance of at least 500m will significantly reduce the disease pressure from blackleg on this season’s crop. Spores of the blackleg pathogen are released from old canola stubble onto emerging canola crops. The greater the distance from this inoculum source the better.

3. **Apply seed dressing or fungicide-amended fertiliser.** Application of a fungicide seed dressing or use of fungicide amended fertiliser will provide extra protection from blackleg in the critical early stages of crop emergence and establishment. In high blackleg pressure situations this is very important.

4. **Foliar fungicides.** In certain situations it may be economical to apply a foliar fungicide to extend the length of protection from blackleg, such as if disease severity is very high, if genetic resistance is inadequate or has been overcome by the fungus. Results of field experiments indicated that use of a fungicide seed dressing in combination with the application of a foliar fungicide gives good levels of protection. Timing is crucial, with an application at the 4-6 leaf growth stage found to be significant in decreasing blackleg infection. However, the benefits are only found in those canola cultivars with a low level of resistance to blackleg and in situations of high disease pressure.

5. **Canola resistance groups.** The blackleg fungus has a high propensity to overcome resistance in *Brassica napus* (canola) cultivars as it is sexually reproducing, resulting in enormously diverse populations. Therefore, the fungal population evolves very rapidly and responds quickly to selection pressures such as wide-scale sowing of cultivars with specific resistance genes. This will lead to resistance being overcome when cultivars of the same resistance gene are sown for 3 or more years. However, we can use the fungal life traits to manipulate the fungal population, by changing cultivars with different sources of resistance, the selection pressure on the fungal population is constantly changing. All canola cultivars and NVT lines have been classified for blackleg resistance genes and placed into resistance groups. This now allows producers to change or rotate canola cultivars after every 2 to 3 years and prevents the build up of isolates that can overcome resistance. By changing canola cultivars at least every 3 years to a cultivar containing different resistance genes, you are likely to reduce yield losses and reduce the probability of resistance breakdown occurring.

*Be sure to check the GRDC website for the latest version of the Blackleg management guide, which will give the latest blackleg disease ratings and resistance groups.*

Sclerotinia stem rot – the new disease challenge

How does the disease develop?

The fungal pathogen that causes sclerotinia stem rot is called *Sclerotinia sclerotiorum*. This fungus can infect over 300 plant species, mostly broadleaf plants, including many crop, pasture and weed species. This includes plants like canola, lupin, chickpea, sunflower, lucerne, cape weed, and shepherds purse. The main features of the disease are:
1. Airborne spores of the fungus are released from apothecia (a small, golf tee shaped structures, 5 – 10 mm in diameter) which germinate from sclerotia in the soil. For this to occur prolonged moist soil conditions in combination with moderate temperatures of 15°C to 25°C are considered ideal. Most sclerotia will remain viable for up to 3 – 4 years then survival slowly declines.

2. Spores of the sclerotinia pathogen cannot infect canola leaves and stems directly. They require petals as a food source for spores to germinate, grow and colonise the petal. When the infected petal eventually drops, it may become lodged onto a leaf, within a leaf axil or at branch junctions along the stem. If conditions are moist the fungus grows out of the petal and invades healthy plant stem tissue which will result in a stem lesion and production of further sclerotia within the stem which will be returned to the soil after harvest.

3. Sclerotia also have the ability to germinate in the soil, produce mycelium and directly infect canola plants in close proximity, causing a basal infection.

4. Weather conditions during flowering play a major role in determining the development of the disease. The presence of moisture during flowering and petal fall will determine if sclerotinia develops. Dry conditions during this time can quickly prevent development of the disease, hence even if flower petals are infected, dry conditions during petal fall will prevent stem infection development.

Research findings in 2013

A number of commercial canola crops were monitored for the development of sclerotinia stem rot in 2013 in southern NSW. These crops were around Cootamundra and south of Henty, in traditionally high disease risk districts. Results from observations within these crops found a very strong relationship between leaf wetness and stem rot development. While the level of stem rot development varied between the crops south of Henty and those at Cootamundra, it was found that extended periods of continual leaf wetness of at least 24 hours or longer were critical for stem rot development in both regions.

There was also two distinct phases identified in the development of the disease. It was found that petal infection provided the first phase in the initial establishment of stem rot within the crop. The second phase occurred once canopy closure occurred and a humid microclimate was established, with the infection and retention of plant tissue under the crop canopy providing opportunities for continual disease development later in the season. This tissue included lower leaves and senescent leaves that became colonised and later adhered to stems, causing stem lesion development and yield loss. This work will continue in 2014 to collect and collate data which will be used to develop a disease prediction model for NSW.

What regions are at risk?

In northern NSW, warmer winter temperatures result in faster development times for canola compared to southern NSW. Generally, spring rainfall is also less in the north which results in fewer potential infection periods and opportunities for the disease to develop. High yielding districts tend to develop sclerotinia stem rot more readily, as this is often related to spring rainfall. Regions such as the Liverpool Plain would be a higher risk for sclerotinia stem rot due to higher rainfall and intensity of host crops within the cropping rotation. Traditionally outbreaks of stem rot tend to be sporadic and seasonal, depending on the timing of spring rainfall and leaf wetness duration. Differences in the level of disease can occur in close proximity in any year depending on rainfall patterns.
What are the indicators that sclerotinia stem rot could be a problem in 2014?

- Epidemics of sclerotinia stem rot generally occur in districts with reliable spring rainfall during the flowering period for canola.

- Use the past frequency of sclerotinia stem rot outbreaks in the district as a guide to the likelihood of a sclerotinia outbreak. Paddocks with a recent history of sclerotinia are a good indicator of potential risk, as well as those paddocks that are adjacent.

- Consider the frequency of sclerotinia host crops in the cropping rotation. These crops will maintain viable sclerotia in the soil by adding new sclerotia, and hence, provide a ready source of inoculum when conditions are favourable.

- The commencement of flowering can determine the severity of a sclerotinia outbreak. Spore release, petal infection and stem infection have a better chance of occurring when conditions are wet for extended periods, especially for more than 24 hours. Canola crops which flower earlier in winter, when conditions are cooler and wetter, are more prone to disease development.

If I had sclerotinia in my canola crop last year, what should I do this season?

The biggest challenge in managing sclerotinia stem rot is deciding whether or not there is a risk of disease development and what will be the potential yield loss. Research in Australia and Canada has shown that the relationship between the presence of the pathogen (as infected petals) and development of sclerotinia stem rot is not very clear due to the strong reliance on moisture for infection and disease development.

Important management options include:

1. **Sowing canola seed that is free of sclerotia.** This applies to growers retaining seed on farm for sowing. Consider grading seed to remove sclerotia that would otherwise be sown with the seed and infect this season’s crop.

2. **Separate this season’s paddock away from last year’s canola stubbles.** Not only does this work for other diseases such as blackleg, but also for sclerotinia.

3. **Rotate canola crops.** Continual wheat/canola rotations are excellent for building up levels of viable sclerotia in the soil. A 12 month break from canola is not effective at reducing sclerotial survival. Consider other low risk crops such as cereals, field pea or faba bean.

4. **Follow recommended sowing dates and rates for your district.** Canola crops which flower early, with a bulky crop canopy are more prone to developing sclerotinia stem rot. Bulky crop canopies retain moisture and increase the likelihood of infection. Wider row spacings can also help by increasing air flow through the canopy to some degree until the canopy closes.

5. **Consider the use of a foliar fungicide.** Weigh up yield potential, disease risk and costs of fungicide application when deciding to apply a foliar fungicide.

6. **Monitor crops for disease development and identify the type of stem infection.** Main stem infections cause the most yield loss and indicate infection events early in the growing season. Lateral branch infections cause lower levels of yield loss and indicate infection events later in the growing season.
When is the best time to apply a foliar fungicide?

Research in Australia and Canada has shown that an application of foliar fungicide around the 20% - 30% flowering stage (20% flowering is 14 – 16 flowers on the main stem, 30% flowering is approx. 20 flowers on the main stem) can be effective in reducing the level of sclerotinia infection. The objective of the fungicide application is to prevent early infection of petals while ensuring that fungicide also penetrates into the lower crop canopy to protect potential infection sites (such as lower leaves, leaf axils and stems). Timing of fungicide application is critical.

In 2013 some commercial crops which received an application of foliar fungicide still developed stem rot later in the season. This is not unexpected as the fungicide will have a limited period of protection during a time of rapid plant growth and that the main aim of foliar fungicide applications is the prevention of main stem infections, which cause the greatest yield loss. Development of lateral branch infections later in the season is not uncommon, and will cause lower yield loss.

Consult the Sclerotinia Stem Rot in Canola factsheet for further information. This publication is available from the GRDC website.

Other disease threats - Powdery Mildew

Powdery mildew is emerging as a challenge for canola producers in the north. Milder winter temperatures are resulting in this disease developing in canola crops at an earlier growth stage compared to southern NSW. Traditionally in the south, powdery mildew will develop late in the season during mid to late podding and causes very little to no yield loss. Mild daily temperatures with cool nights that favour dew formation are ideal for powdery mildew to develop.

The impact on yield by the earlier development of powdery mildew in northern NSW is largely unknown. Currently there are no fungicides registered to control powdery mildew in canola, but certain fungicides registered for blackleg control are known to control powdery mildew as well. Research trials will be conducted in collaboration with NGA in 2014 to look at this disease in more detail and determine management options for producers.

Contact details

Kurt Lindbeck
NSW Department of Primary Industries,
Wagga Wagga Agricultural Institute
Ph: 02 69 381 608
Email: kurt.lindbeck@dpi.nsw.gov.au

Joop van Leur
NSW Department of Primary Industries,
Tamworth Agricultural Institute
Ph: 02 67 631 204
Email: joop.vanleur@dpi.nsw.gov.au

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Canola agronomy research in central NSW

Leigh Jenkins¹ and Rohan Brill²

¹NSW DPI Trangie
²NSW DPI Wagga Wagga

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Canola, hybrid, open-pollinated, establishment, plant population, phosphorus, nitrogen

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Take home messages:
- Hybrid canola has significant grain yield and farming system benefits for the central region of NSW.
- Aim to establish 20-25 plants/m² in central west NSW.
- Choose canola varieties with large seed size to improve crop establishment (> 5 g/1000 seeds).
- Phosphorus application improves grain yield regardless of variety choice, but limit the amount of P applied in direct contact with seed.
- The response to nitrogen application is generally positive, even at relatively high soil N levels.

Introduction

Hybrid canola

Hybrid canola production has increased markedly in recent seasons, due largely to improved early vigour and higher grain yield relative to open-pollinated (OP) varieties. Hybrid seed generally retails for approximately double the cost of commercial OP seed. This increased cost to the grower is mainly due to the higher cost of seed production, as producing hybrid seed involves production of seeds of the parent lines in the first step and then the F1 hybrid in the second step. The yield and vigour advantage of hybrids is known as heterosis. Hybrids can be either GM or non-GM, and are now available in each of the four commercially available canola herbicide tolerance groups.

VSAP trials background

Canola agronomy trials have been conducted by NSW DPI in the central region of NSW in 2012 and 2013 (locations listed in Table 1). These trials add value to NVT by testing popular commercial varieties across a range of agronomic treatments. The aim of the trials has been to test specific groups of canola plant types, such as comparing hybrid varieties with OP varieties as well as comparing triazine tolerant (TT) varieties with non-TT varieties.
### Table 1. NSW DPI canola trials conducted in the central region of NSW in 2012 and 2013.

<table>
<thead>
<tr>
<th>Season</th>
<th>Site</th>
<th>Trial</th>
<th>Soil type</th>
<th>Colwell P 0-10 cm (mg/kg)</th>
<th>Nitrogen 0-90 cm (kg/ha)</th>
<th>Sowing date</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>Coonamble</td>
<td>Variety x Phosphorus Variety x Sowing depth</td>
<td>Brown chromosol</td>
<td>76</td>
<td>56</td>
<td>21-Apr</td>
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<tr>
<td></td>
<td></td>
<td>Variety x Sowing depth</td>
<td></td>
<td></td>
<td></td>
<td>21-Apr</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Variety x Nitrogen x Phosphorus Variety x Plant population Variety x Sowing depth</td>
<td>Red chromosol</td>
<td>22</td>
<td>N/A</td>
<td>17-Apr</td>
</tr>
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<td></td>
<td></td>
<td>Variety x Sowing depth</td>
<td></td>
<td></td>
<td></td>
<td>17-Apr</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Variety x Sowing depth</td>
<td></td>
<td></td>
<td></td>
<td>17-Apr</td>
</tr>
<tr>
<td></td>
<td>Nyngan</td>
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<td>112</td>
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<td></td>
<td></td>
<td></td>
<td>7-May</td>
</tr>
<tr>
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<td>9</td>
<td>62 (0-60 cm)</td>
<td>26-Apr</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Variety x Phosphorus Variety x Sowing depth</td>
<td></td>
<td></td>
<td></td>
<td>28-May</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Variety x Sowing depth</td>
<td></td>
<td></td>
<td></td>
<td>28-May</td>
</tr>
<tr>
<td></td>
<td>Gitgandra</td>
<td>Variety x Nitrogen</td>
<td>Brown chromosol</td>
<td>29</td>
<td>54 (0-60 cm)</td>
<td>27_Apr</td>
</tr>
<tr>
<td></td>
<td>Wellington</td>
<td>Variety x Nitrogen</td>
<td>Red chromosol</td>
<td>29</td>
<td>54 (0-60 cm)</td>
<td>27_Apr</td>
</tr>
<tr>
<td>2013</td>
<td>Nyngan</td>
<td>Variety x Phosphorus Variety x Nitrogen Variety x Plant population Variety x Sowing depth</td>
<td>Red chromosol</td>
<td>24</td>
<td>180</td>
<td>19-Apr</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Variety x Nitrogen</td>
<td></td>
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<td></td>
<td></td>
<td>Variety x Sowing depth</td>
<td></td>
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<td>19-Apr</td>
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<tr>
<td></td>
<td>Trangie</td>
<td>Variety x Phosphorus Variety x Nitrogen Variety x Plant population Variety x Sowing depth</td>
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<td>86</td>
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<td>Variety x Sowing depth</td>
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<td>28-May</td>
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<tr>
<td></td>
<td></td>
<td>Variety x Sowing depth</td>
<td></td>
<td></td>
<td></td>
<td>28-May</td>
</tr>
</tbody>
</table>

**Trial results**

**Plant population**

A plant population trial was sown at Nyngan in 2012, with actual establishment being similar to the targeted rate. Grain yield was significantly higher for all varieties when plant population increased from 10 to 25 plants/m² (average 0.35 t/ha increase), but there was no further yield increase for 40 and 60 plants/m² (Figure 1). The hybrid Clearfield variety 43Y85 (CL) was significantly higher yielding than the OP Clearfield variety Pioneer 43C80(1) (CL). Similarly, the hybrid TT variety Hyola 555TT was significantly higher yielding than the OP TT variety ATR-Stingray(1).
At Nyngan in 2013, the achieved establishment rates were similar to the targeted rates but at Trangie the achieved establishment was approximately 50% of the targeted establishment. At Nyngan there was a significant yield increase (averaged across all varieties) of 0.42 t/ha where plant population increased from 5 to 10 plants/m², but there was no further grain yield response from increasing population further (Figure 2). At Trangie there was a significant grain yield increase (averaged across all varieties) where the targeted population increased to 40 plants/m². In effect this meant that maximum yield was achieved at 20 plants/m² since the actual establishment was 50% of the targeted establishment at this site (Figure 3).

There was a similar varietal response pattern in 2013 at both sites as for the one site at Nyngan in 2012. The hybrid Clearfield variety Pioneer 44Y84 (CL) was significantly higher yielding than the OP Clearfield variety Pioneer 43C80 (CL); and the hybrid TT variety Hyola 559TT was significantly higher yielding than the OP TT variety ATR-Stingray.
Sowing depth

Sowing depth trials were conducted at Coonamble, Nyngan and Trangie in 2012; and at Nyngan and Trangie in 2013. Each trial had six common varieties with a range in seed size (Table 2). Target seeding depths were 2.5 cm, 5 cm and 7.5 cm.

Table 2. Seed size and number of seeds sown in three canola variety sowing depth trials in 2012

<table>
<thead>
<tr>
<th>Variety</th>
<th>Seed weight 2012 (g/1000 seeds)</th>
<th>Seed weight 2013 (g/1000 seeds)</th>
<th>Seeds sown/m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>AV-Garnet</td>
<td>3.78</td>
<td>3.27</td>
<td>60</td>
</tr>
<tr>
<td>ATR-Stingray</td>
<td>3.06</td>
<td>2.97</td>
<td>60</td>
</tr>
<tr>
<td>Pioneer 43C80 (CL)</td>
<td>3.68</td>
<td>4.11</td>
<td>60</td>
</tr>
<tr>
<td>Pioneer 43Y85 (CL)</td>
<td>5.03</td>
<td>4.77</td>
<td>60</td>
</tr>
<tr>
<td>Pioneer 44Y84 (CL)</td>
<td>5.34</td>
<td>5.20</td>
<td>60</td>
</tr>
<tr>
<td>Hyola 555TT</td>
<td>4.26</td>
<td>4.00</td>
<td>60</td>
</tr>
</tbody>
</table>

In 2012, averaged across all trials and varieties, establishment (as a percentage of seeds sown) at the 2.5 cm target depth was approximately 66%, with no difference between varieties. All varieties had reduced establishment at the 5 cm sowing depth compared to the 2.5 cm sowing depth, with the exception of Pioneer 44Y84 (CL) which had the largest seed size (Figure 4.). At the 7.5 cm sowing depth the difference between varieties and seed size became more marked as the largest seeded variety achieved 50% establishment compared to 20% establishment for the smallest seeded variety.
The effect of sowing depth on grain yield was greater in 2013 than 2012 but was still of a lesser magnitude than the effect of sowing depth on establishment. At Nyngan, the grain yield of Pioneer 44Y84 (CL), AV-Garnet, and Hyola 555TT were all similar for the 2.5 cm sowing depth; however AV-
Garnet and Hyola 555TT both had a significant grain yield reduction at the 5 cm and 7.5 cm sowing depths, while Pioneer 44Y84 (CL) did not suffer a yield penalty from deeper sowing. At Trangie, all varieties suffered a grain yield penalty as sowing depth was increased but this reduction in grain yield was less severe for the larger seeded varieties.

**Phosphorus rate**

A phosphorus (P) rate trial was sown at Coonamble, Nyngan and Trangie in 2012. The phosphorus product used was triple super which does not supply any nitrogen. The phosphorus rates applied were 0, 5, 10 and 20 kg/ha, with the fertiliser being placed directly with the seed.

![Figure 6. Average establishment of four canola varieties sown with four rates of phosphorus at Trangie, Nyngan and Coonamble in 2012](image)

There was no effect of phosphorus rate on canola establishment on the cracking clay (grey vertosol) soil at Trangie. In contrast, increasing P rate significantly reduced the establishment of all varieties on the lighter textured soils at Nyngan (red chromosol) and Coonamble (brown chromosol) (Figure 6). All varieties experienced a similar reduction in establishment, regardless of seed size or plant type.

At Nyngan, there was a grain yield increase of 0.16 t/ha for the 5 kg/ha P rate compared with the nil P rate but with no further grain yield increase where P rate was increased. At Trangie (19 mg/kg Colwell P) the application of 10 kg/ha P significantly increased grain yield by 0.14 t/ha compared to where no P was applied, with no further yield increase at the 20 kg/ha P rate. There was a similar varietal response pattern for the phosphorus rate trials at all sites as for the plant population trials. The hybrid Clearfield variety Pioneer 44Y84 (CL) was significantly higher yielding than the OP Clearfield variety Pioneer 43C80(CL); and the hybrid TT variety Hyola 555TT was significantly higher yielding than the OP TT variety ATR-Stingray(CL).

Two further phosphorus rate trials were conducted in 2013, with the Trangie trial planted on a lighter textured soil (red chromosol) compared with a heavy (grey vertosol) soil in 2012. There was a significant reduction in canola establishment at both sites as phosphorus rate (applied as triple super) was increased (Figure 7). Further product comparisons at a common P rate (20 kg/ha) showed that all major phosphate fertilisers (MAP, DAP, Single Super, Triple Super, Supreme Z) affected establishment to a similar degree.
Despite the effect on establishment, grain yield still responded positively to phosphorus application at Nyngan in 2013 (24 mg/kg Colwell P), with the 5 kg/ha P rate yielding 0.25 t/ha more than the nil P treatment, but there was no further yield increase beyond this rate. There was no grain yield response from the application of phosphorus at Trangie (28 mg/kg Colwell P), which could have been partly due to the reduction in plant numbers caused by the fertiliser application.

Although hybrid varieties had higher yield than OP varieties in these phosphorus trials, there was no evidence to suggest that they should be managed differently in terms of P nutrition.

For growers using a tine seeder it is generally possible (and recommended) to separate seed from fertiliser to avoid the negative effects of starter fertiliser. For growers with a disc seeder (or considering a disc seeder), there are several management options available such as:

- Planting on relatively narrow crop rows to reduce fertiliser concentration in the furrow,
- Planting canola early to allow greater root exploration, with potentially less phosphorus application required,
- Pay strict attention to closing devices. The firmer/heavier the closing device, the greater the negative impacts of phosphorus fertiliser.

**Nitrogen rate and timing**

Nitrogen (N) rate trials were sown in 2012 at Nyngan and Trangie, with split timing of application component included at Gilgandra and Wellington. In 2013 nitrogen rate and timing trials were sown at Nyngan and Trangie only, with applications split between sowing and the early stem elongation stage. Due to lack of adequate follow-up rain at both Nyngan and Trangie sites after the in-crop application, only the rate component of 2013 trials is reported here.

At Nyngan in 2012, the application of 30 kg/ha N increased grain yield by 0.26 t/ha averaged across all varieties. Increasing the N application rate from 30 to 60 kg/ha resulted in a further yield increase of 0.21 t/ha (Figure 8).
Only two varieties were sown at Trangie in 2012; however both varieties responded positively to nitrogen application at sowing despite a moderately high soil nitrogen content (112 kg/ha N at sowing, 0-90 cm) (Figure 9).

For the 2012 Gilgandra and Wellington sites, longer maturity canola varieties were sown to reflect yield potential in a longer season, higher rainfall environment.

At Gilgandra, the application of 40 kg/ha of N at sowing significantly increased the yield of only one of the four varieties (45Y82 CL, by 0.55 t/ha). There was no yield affect beyond the 40 kg/ha rate, possibly reflecting a moderate level of soil N at sowing (62 kg/ha) due to previous paddock history of lucerne pasture in 2010 (Figure 10). However the Gilgandra site did show a 2.1% reduction in oil concentration as nitrogen rate was increased from nil to 80 kg/ha.
At Wellington there was a significant yield response as nitrogen rate applied at sowing was increased from 0 to 40 kg/ha (0.33 t/ha) and also from 40 to 80 kg/ha (0.19 t/ha) (Figure 11). The difference in response between this and Gilgandra site may be due to paddock history, with Wellington site having slightly lower soil N at sowing (54 kg/ha) after a history of wheat in 2011 and canola in 2010. However there was no effect of increasing N rate on oil concentration at the Wellington site. Non-TT varieties (AV-Garnet and 45Y82 CL) were significantly higher yielding than TT varieties in this trial.

The Wellington site was the only site in 2012 where the yield of an OP variety, AV-Garnet, had similar yield to the highest yielding hybrid variety, Pioneer 45Y82 (CL).

Both Gilgandra and Wellington 2012 trials included a timing component, where N was applied just prior to stem elongation (40 kg/ha rate only). Both trials had significantly less (0.15 t/ha) grain yield where N was delayed compared to applied at sowing, most likely due to lack of follow-up in-crop rain post application.

At Nyngan in 2013, there was a significant effect of nitrogen application on grain yield, with the application of 30 kg/ha N increasing grain yield by 0.27 t/ha, compared to nil N applied (Figure 12). This site was high in soil N at sowing (180 kg/ha N) but still showed a favourable response to a moderate amount of N application. There were similar varietal trends as observed in previous trials.
Figure 12. Grain yield of four canola varieties with four nitrogen rates at Nyngan in 2013

At Trangie in 2013 there was only a small response to nitrogen application but there were large varietal differences, with this trial following a similar trend to other trials that showed an advantage of hybrid varieties over OP varieties (Figure 13).

Although N application can increase grain yield, it may reduce oil concentration in the grain, as shown at Gilgandra in 2012. Overall oil removed (by weight as kg/ha) is still generally higher where N is applied. It is also worth noting that at a grain yield of 1.5 t/ha and a canola price of $450/tonne, the economic value of 1 % oil concentration is equivalent to only 22.5 kg/ha grain.
Discussion

**Hybrid vs. OP varieties**

These 2012 and 2013 canola trials have shown that the extra cost of hybrid seed can be justified. Averaged across all VSAP trials in the central-west region in the past two seasons, the average grain yield benefit of hybrid canola over OP canola was 0.4 t/ha (Table 3).

**Table 3.** Grain yield (t/ha) comparison of hybrid and open-pollinated (OP) canola varieties averaged across trials at VSAP canola trial sites in the central-west region in 2012 and 2013.

<table>
<thead>
<tr>
<th></th>
<th>Hybrid</th>
<th>OP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coonamble</td>
<td>1.8</td>
<td>1.4</td>
</tr>
<tr>
<td>Gilgandra</td>
<td>2.3</td>
<td>1.9</td>
</tr>
<tr>
<td>Nyngan</td>
<td>1.5</td>
<td>0.9</td>
</tr>
<tr>
<td>Trangie</td>
<td>1.5</td>
<td>1.2</td>
</tr>
<tr>
<td>Wellington</td>
<td>2</td>
<td>1.9</td>
</tr>
<tr>
<td><strong>2012</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>2013</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nyngan</td>
<td>1.8</td>
<td>1.3</td>
</tr>
<tr>
<td>Trangie</td>
<td>1.3</td>
<td>0.8</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>1.7</strong></td>
<td><strong>1.3</strong></td>
</tr>
</tbody>
</table>

At a canola price of $450/tonne, this equates to a gross income benefit from hybrid varieties of $180/tonne. For growers purchasing commercial seed (assuming $50/ha for hybrid seed and $25/ha for OP seed) the return on investment of the extra money spent on hybrid seed ($25/ha) was on average 620%. Growers who retain their own seed for subsequent planting will reduce seed cost, but there are then the additional costs of labour, grading and seed treatment with fungicide and insecticide. There may also be intangible costs due to the increased risks of poor vigour seed and/or disease carryover in retained seed.

**TT or not TT?**

The use of TT canola adds an extra dimension to weed control options; however this system does come with an inherent penalty as TT varieties are known to have reduced photosynthetic efficiency. The average yield penalty in these trials for TT compared with non-TT varieties was 0.4 t/ha (Table 4). At a canola price of $450/tonne, this equates to a penalty of $180/ha. This needs to be weighed up against the cost of using either cheaper or more targeted herbicides to control specific weed issues, as well as the ability to allow viable crop rotations in paddocks previously considered unsuited to canola production.
Table 4. Grain yield (t/ha) comparison of TT and non-TT canola varieties averaged across trials at VSAP canola trial sites in the central-west region in 2012 and 2013.

<table>
<thead>
<tr>
<th></th>
<th>TT</th>
<th>non-TT</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coonamble</td>
<td>1.3</td>
<td>1.8</td>
</tr>
<tr>
<td>Gilgandra</td>
<td>1.9</td>
<td>2.3</td>
</tr>
<tr>
<td>Nyngan</td>
<td>0.8</td>
<td>1.6</td>
</tr>
<tr>
<td>Trangie</td>
<td>1.1</td>
<td>1.4</td>
</tr>
<tr>
<td>Wellington</td>
<td>1.9</td>
<td>2</td>
</tr>
<tr>
<td>2013</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nyngan</td>
<td>1.4</td>
<td>1.7</td>
</tr>
<tr>
<td>Trangie</td>
<td>1</td>
<td>1.1</td>
</tr>
<tr>
<td>Average</td>
<td>1.3</td>
<td>1.7</td>
</tr>
</tbody>
</table>

Conclusion

Canola agronomy trials focussing on establishment and nutrition issues have been conducted by NSW DPI across a range of soil types (chromosols and vertosols) in the central region of NSW in 2012 and 2013. Despite differing soil types and seasons at each site, trial results have consistently shown the value of large seeded hybrid varieties vs. small seeded OP varieties in particular. From these trials several agronomic practices can be highlighted to increase the reliability of canola production in the central zone of NSW:

- Where seed needs to be placed deeper than optimum seeding depths (e.g. when sowing early by moisture seeking), ensure that canola varieties with larger seed size are used (minimum 5 g per 1000 seeds) and that a high rate of fertiliser in contact with the seed is avoided.
- Positive grain yield response to low-moderate (5-10 kg/ha) phosphorus rates are common and have been recorded on both red and grey soils.
- Aim to establish a target density of 20-25 plants/m² in central-west NSW.
- The application of nitrogen fertiliser has led to increased grain yield of canola, even at moderate to high soil N levels.
- TT varieties have generally been lower yielding than non-TT varieties; however this needs to be weighed up against the options provided by residual herbicides in the TT system.
- Hybrid varieties have generally been higher yielding than open pollinated varieties; however the cost of hybrid seed needs to be weighed up against the reduced cost and ability to retain seed of OP varieties.

Acknowledgements

The assistance of Jayne Jenkins, Scott Richards, Kelvin Appleyard and formerly Robert Pither (NSW DPI, Trangie) in the conduct of these trials is gratefully appreciated.

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Contact details

Leigh Jenkins
NSW Department of Primary Industries
Ph: 0419 277 480
Email: leigh.jenkins@dpi.nsw.gov.au

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- Has excellent systemic and translaminar activity (however, it is not phloem mobile)
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- Is effective against insects which are resistant to other insecticides
- Is an effective rotational partner with other chemistries
- Is soft on beneficial insects (i.e. it is IPM compatible) and predatory mites
- Has a favourable ecotoxicology profile and is not persistent in the environment
- Can be applied by ground-rig in a minimum of 50 L/ha of water. Can be aerially sprayed in a minimum of 30 L/ha of water
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- The combined pack will treat 250 tonnes of grain
- Conserve On-Farm is registered for use on all cereals with the exception of maize, malt barley, rice and PRF grain. It must not be used on pulses, oilseeds or their processed fractions.
- Should Conserve On-Farm be applied twice to a parcel of grain, it is possible that grain MRL violations will occur, endangering overseas trade.
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Viral diseases in canola and winter pulses – impacts and management

Joop van Leur¹, Mohammad Aftab², Murray Sharman³, Kurt Lindbeck⁴

¹NSW – DPI, Tamworth Agricultural Institute, Calala, NSW 2340; ²DEPI Victoria, Horsham, Vic 3400; ³DAFFQ Brisbane, Qld 4001; ⁴NSW - DPI, Wagga Wagga Agricultural Institute, Wagga Wagga, NSW 2650

Key words
Canola, chickpea, BWYV, TuMV, survey, virus resistance

GRDC codes
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Take home message
• Increasing cultivation of canola in the northern region will lead to higher risks of viral and fungal diseases.
• The finding of high levels of Turnip mosaic virus (TuMV) in canola paddocks on the Liverpool Plains could indicate the presence of ‘new’, more virulent, strains, which could have implications for canola cultivation nation-wide. Further screening of canola varieties for TuMV resistance is needed.
• The 2013 season was the second year in a row that high virus-induced losses occurred in chickpea paddocks in the northern region. Dry conditions during the growing season could have favoured the movement of aphid virus vectors. As in the preceding season, severe symptoms appear to be associated with Beet western yellows virus (BWYV) or a closely related virus.
• None of the modern high yielding chickpea varieties have currently adequate virus resistance. However, screening wide ranges of chickpea germplasm for virus resistance showed potential sources of resistance that will be used in the PBA chickpea breeding program.

Plant / virus pathosystems are dynamic

Farming systems in Australia’s northern grain region are continuously evolving with new crops introduced and rotation patterns changed. The past decade has seen large increases of winter pulses, particularly chickpea and faba bean, and canola throughout the region. Increasing use of broadleaf crops can contribute to the sustainability and profitability of broadacre farming through higher soil fertility, better weed control and less stubble and soil borne disease in the following wheat crops. However, a further increase of broad leaf crops, either through shorter rotations between pulse crops or through expansion in new areas, will aggravate its own disease problems. Viral diseases are of particular concern as curative control is not possible and, unlike most fungal diseases, viruses are generally not species specific. Extending pulses and canola cultivation in the northern grain zone, a sub-tropical region characterised by a short and relatively warm winter growing season, will aggravate virus problems. Rain can occur throughout the year in this region and, together with fertile soils with good water holding capacity, allows cultivation of a range of summer crops, rainfed or under irrigation. These summer crops, as well as weeds and volunteers, provide a ‘green bridge’ for pathogens and pests of winter crops between growing seasons. This is especially of importance to virus diseases as most require living plant tissue to survive and need insect vectors (mainly aphids) to spread. Viruses can be classified based on their mode of vector transmission; ‘persistently transmitted’ viruses that require feeding of the vector on the host plant both to acquire and transmit the virus; ‘non-persistently transmitted’ viruses that can be transmitted by brief probing of the vector. Consequently, the vector range of persistently transmitted viruses is
smaller than for non-persistently transmitted viruses and generally restricted to host-specific aphids. On the other hand, non-persistently transmitted pulse viruses can even be transmitted by cereal aphids. A good understanding of virus vector ecology is a prerequisite to the development of virus control packages.

**Chickpea viruses**

Aphid colonisation is not often observed in chickpeas and while high levels of virus symptoms are common in pulse crops that are favoured by aphids, like faba bean, field pea and lentils, virus incidences in chickpeas are generally low. However, the impact of virus infection in chickpeas can be far more severe than in other pulse crops. A wide range of viruses are capable of infecting chickpeas, but – based on regular surveys throughout the Australian winter pulse growing region – three viruses (BWYV, AMV, CMV) are the most common encountered (Table 1). During 2012 unusually high virus incidences were observed in chickpea crops in the northern region, particularly on the Liverpool Plains. Diagnostic tests of symptomatic plants showed mainly BWYV positives (van Leur et al. 2013), but closely related viruses could account for up to 30% of these BWYV-like infections in some paddocks (Moore et al. 2013).

**Canola viruses**

Unlike with chickpea, severe aphid colonisation is common in canola and aphicide sprays are commonly applied to avoid aphid-feeding induced yield losses. Three viruses are reported on canola in Australia (Table 1), but – until now – only high infection levels of BWYV have been found in commercial canola crops. Of the three aphid species that are predominant on canola, the green peach aphid (GPA) is the most BWYV efficient vector, but cabbage and turnip aphids are capable of transmitting BWYV at a lower efficiency. All three aphid species can transmit TuMV and CaMV. Compared to pulse viruses, canola viruses have received very little research attention in Australia so far.

**Interaction between chickpea and canola viruses**

The rapidly expanding canola cultivation in the northern grain region could potentially become a source of BWYV infection for chickpea crops: The virus could build up in early sown canola crops and move to the later sown chickpea crops in early spring. Green peach aphid feeds on a large number of plant species, including chickpeas. TuMV has as well been reported in chickpeas (Schwinghamer et al. 2007).

The possible interaction between chickpea and canola viruses and the lack of research on canola viruses prompted GRDC to fund a short term project; ‘Scoping Study on Canola Viruses in Northern Australia: Occurrence and Variety Performance’ (DAN00179).

**Development of canola and winter pulse viruses during the 2013 season in the northern grain zone.**

Similarly to the preceding season, extended drought conditions prevailed during July – September throughout the northern region in 2013. Little or no virus was found in early sown faba bean crops, but - similarly to 2012 – high incidences of severe symptoms were observed in a number of chickpea paddocks by mid September. Diagnostic tests showed BWYV (or a closely related virus) associated with symptoms in the severely affected parts of the northern part of the region. Chickpea paddocks in the southern part of the surveyed region only showed low levels of symptoms, mainly caused by AMV with a lower incidence of CMV (Sharman et al. 2014). Testing of virus symptomatic chickpea plants for TuMV did not yield any positives.
Table 1. Priority viruses for winter pulses and brassicas in the northern grain region

<table>
<thead>
<tr>
<th>Virus</th>
<th>Abbreviation</th>
<th>Mode of transmission</th>
<th>Faba bean</th>
<th>Chickpea</th>
<th>Canola</th>
<th>Mustard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bean leafroll</td>
<td>BLRV</td>
<td>persistent pea, cowpea aphids</td>
<td>high</td>
<td>moderate</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Soybean dwarf</td>
<td>SbDV</td>
<td>persistent pea, cowpea aphids</td>
<td>high</td>
<td>moderate (?)</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Bean yellow mosaic</td>
<td>BYMV</td>
<td>non-persistent many aphid species</td>
<td>moderate</td>
<td>low</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Alfalfa mosaic</td>
<td>AMV</td>
<td>non-persistent many aphid species</td>
<td>low</td>
<td>high</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Cucumber mosaic</td>
<td>CMV</td>
<td>non-persistent many aphid species</td>
<td>low</td>
<td>high</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Beet western yellows</td>
<td>BWYV</td>
<td>pea, peach, cabbage aphids</td>
<td>low</td>
<td>high</td>
<td>high</td>
<td>high</td>
</tr>
<tr>
<td>Turnip mosaic</td>
<td>TuMV</td>
<td>non-persistent many aphid species</td>
<td>no</td>
<td>low</td>
<td>potentially high</td>
<td>high</td>
</tr>
<tr>
<td>Cauliflower mosaic</td>
<td>CaMV</td>
<td>non-persistent many aphid species</td>
<td>no</td>
<td>no</td>
<td>???</td>
<td>???</td>
</tr>
</tbody>
</table>

Canola paddocks were surveyed several times during the season from randomly taken samples of at least 50 plants/paddock. If present, samples were also taken from brassica weeds (mainly turnip weed) in or close to the surveyed paddocks. Only low (< 5%) BWYV infections were found in canola crops or weed populations until September. However, all canola crops sampled after mid September were BWYV infected with an incidence of > 40% in 8 out of 13 crops. The highest level of infection was found in a crop near Wellington with 93% infected plants. BWYV also appeared in the weed samples around the same time as in the canola crops.

Highly variable TuMV incidences were found between turnip weed populations, with 83% infection already by the end of July in a population near North Star. However, other turnip weed populations sampled in that area on the same day were virus free. TuMV infection of canola was rare; out of the 51 canola paddocks surveyed during the 2013 season, 44 were TuMV free. All 7 TuMV infected paddocks were located on the Liverpool Plains with one paddock showing 100% infection on October 1. Low levels of CaMV were found in a few turnip weed populations.

The localised, but very high, TuMV infection in commercial canola crops is a significant finding. Overseas studies report the destructive potential of this virus and our preliminary tests with TuMV strains isolated from canola crops showed severe growth reduction after inoculation. While the susceptibility of brassica weeds and Indian mustard cultivars to TuMV is known, surveys carried out a decade earlier in the same region indicated resistance of canola to local TuMV strains (Hertel et al. 2004). The establishment of new, more virulent, virus strains is a possible explanation.

Control options

Chemical and cultural

Virus management through the control of aphid vectors by insecticides is possible for persistently transmitted viruses as they require extended feeding periods, but is of little use for non-persistently transmitted ones. Seed treatment by systemic insecticides can control early virus infections (like BLRV in faba bean), but is unlikely to be effective for late infections. The treatment of canola seed with the systemic insecticide imidacloprid to control soil-borne seedling pests might provide some protection, but treatment rates are likely too low to be fully effective.

Cultural and agronomic practices that are aimed at improving plant growth, like weed control, proper plant nutrition, correct sowing rates and sowing into stubble, will reduce virus risks and/or increase plant resistance and competition ability (Jones 2004).
Genetic resistance

Improved disease resistance is the most economic and environmentally sustainable way to control diseases, fungal or viral. Over the past decade good progress has been made in the Australian faba bean and field pea breeding programs and new varieties with adequate resistance to the priority viruses are now available. Systematic screening for virus resistance in chickpeas started three years ago in collaboration with the International Centre for Agricultural Research in the Dry Areas (ICARDA) as part of a GRDC funded project. Screening in northern NSW is done at the NSW-DPI Liverpool Plains Field Station (LPFS). Virus development in these screening nurseries is monitored through regular diagnostic tests. Both in 2012 and 2013 BWYV caused a high incidence of severe virus symptoms. Figure 1 shows the incidence of virus symptoms in chickpea breeding lines compared to two check varieties, Gully and PBA Slasher. The variety Gully was developed through mass selection made in an Iranian germplasm accession under high virus pressure in 1992 at the LPFS, is not grown commercially because of its high susceptibility to Ascochyta blight. None of the breeding material showed a level of BWYV resistance comparable to Gully and its good performance demonstrates the potential of genetic virus resistance. Screening of a wide range of chickpea germplasm Fig. 1. Incidence of virus symptoms in 91 desi and 60 kabuli chickpea breeding lines and 2 check varieties on two different scoring dates, LPFS, 2013

The 2013 season was the first season in which canola and Indian mustard (B. juncea) lines were tested for virus resistance. A total of 40 canola and 8 juncea breeding lines from different breeding programs were sown in the LPFS. On 24 September BWYV and TuMV infection was tested on a random sample of 15 plants from each of 3 replicates. BWYV incidence was relatively low and no significant difference between the tested lines was found. However, high levels of TuMV infection were found both in the canola and especially in the juncea lines tested (Figure 2). None of the tested lines was TuMV-free, but two canola breeding lines had < 10% infection.
Fig 2. Infection level of Beet western yellows virus and Turnip mosaic virus in 40 canola and 8 juncea varieties, LPFS, 24 Sep 2013

1 Percentage TBIA positive plants, average over 15 randomly collected plants in each of 3 replicates.

Figure 2. Infection level of Beet western yellows virus and Turnip mosaic virus in 40 canola and 8 juncea varieties, LPFS, 24 Sep 2013

1 Percentage TBIA positive plants, averaged over 15 randomly collected plants in each of 3 replicates.

Conclusions

High incidences of virus symptoms in chickpea paddocks during 2013 showed again the destructive potential of viruses in this crop. Continuous monitoring of crops remains necessary as the virus spectrum can change. Correct identification of viruses and virus vectors is a high priority for the crop protection research programs.

More data are needed to quantify the importance of viruses in canola. However, the high incidence of TuMV in canola paddocks on the Liverpool Plains may have implications for canola cultivation nation wide.

References


## Contact details

<table>
<thead>
<tr>
<th>Name</th>
<th>Phone</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joop van Leur</td>
<td>02 6763 1204</td>
<td><a href="mailto:joop.vanleur@dpi.nsw.gov.au">joop.vanleur@dpi.nsw.gov.au</a></td>
</tr>
<tr>
<td>Mohammad Aftab</td>
<td>03 5362 2353</td>
<td><a href="mailto:mohammad.aftab@depi.vic.gov.au">mohammad.aftab@depi.vic.gov.au</a></td>
</tr>
<tr>
<td>Murray Sharman</td>
<td>07 3255 4339</td>
<td><a href="mailto:murray.sharman@qld.gov.au">murray.sharman@qld.gov.au</a></td>
</tr>
<tr>
<td>Kurt Lindbeck</td>
<td>02 6938 1608</td>
<td><a href="mailto:kurt.lindbeck@dpi.nsw.gov.au">kurt.lindbeck@dpi.nsw.gov.au</a></td>
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</table>

## Reviewed by

Guy McMullen
Viral diseases in chickpeas – impact and management

Murray Sharman¹, Kevin Moore², Joop van Leur², Mohammad Aftab³, Andrew Verrell²

¹ DAFFQ Ecosciences Precinct Brisbane, ² NSW DPI Tamworth, ³ DEPI Vic Horsham

Key words
viruses, agronomy, surveys, diagnostics

GRDC codes
DAQ00186, DAN00179, DAN00140, DAN00143, DAN00171, DAN00176, DAV00134

Take home message
Minimise risk of virus by retaining standing stubble, planting on time and at optimal seeding rate for rapid canopy closure. Control weeds in and around crop and ensure adequate plant nutrition

Viruses in chickpea crops
Chickpea and other winter pulse crops are susceptible to many plant viruses. The effects on plants include stunting, reddening, chlorosis, distortion, shoot tip wilting, reduced yield and grain quality and for chickpeas, often premature death. Infections occurring early in the cropping cycle generally result in more severe disease outbreaks and yield losses. All are spread by flying insect vectors and almost all can be separated into two main groups, those that are transmitted by aphids persistently and those that are transmitted non-persistently. Persistently transmitted viruses (eg Beet western yellows virus - BWYV, Bean leaf roll virus - BLRV) include the luteoviruses and poleroviruses where the aphids can retain and transmit the viruses for many weeks but require up to 1-2hrs of feeding to transmit. Pea aphid, green peach aphid and cowpea aphid are considered to be important vectors of chickpea viruses. Non-persistently transmitted viruses (eg Alfalfa mosaic virus – AMV, Cucumber mosaic virus – CMV) are only carried by aphids for a few hours but can be transmitted in less than a minute of feeding. Some chickpea viruses are also transmitted by leaf hoppers. Virus disease outbreaks in chickpeas are sporadic and difficult to predict from season to season or between locations. Major outbreaks of virus diseases in chickpeas occurred in the early 1990s (when losses in many chickpea crops on the Liverpool Plains reached 100%) and most recently in 2012 in several regions of NSW.

Impact of viruses in chickpea crops in northern region in 2013
In 2013, virus infection was found in almost all chickpea crops inspected from southern QLD to Wellington in the south. The incidence of virus infection was generally lower than observed in 2012 with most crops inspected having <5% plants with symptoms but it was as high as 30-50% in several crops from the Breeza / Werris Creek area and Edgeroi. Overall, the most prevalent virus was BWYV and in some locations more than 90% of symptomatic plants were infected with BWYV (Table 1). There are related virus species that also react with the BWYV assay as is discussed further below, so it is likely there was a mix of BWYV-like viruses present at many locations. Some of the main outcomes from the chickpea surveys in N-NSW were:

- Higher proportion of BWYV infections found at, and north of the Liverpool Plains. Higher proportion of AMV infections in the south (Table 1). Very low levels of BLRV and CMV.
- Up to 15% of non-symptomatic plants still had BWYV infection from the Liverpool plains.
- Accurate identification by PCR has shown the aphid transmitted luteovirus species to have a wide geographical range in a number of alternative weed hosts (Table 2).
Soybean dwarf virus (SbDV) was the major virus affecting several crops in the Edgeroi region in Oct 2013 and was confused with BWYV in the antibody test (Table 1).

Using the virus species-specific PCR described below, 49 virus affected plants from 2013 were screened consisting of 38 SbDV, 5 PhBV, 3 BWYV, 2 BLRV and 1 mixed SbDV/BWYV. From the 45 samples that were not BWYV by PCR, 33 were false positives in the BWYV antibody assay. This demonstrates the BWYV antibody used (from DSMZ) was not useful for identifying BWYV and PCR indicated that SbDV was the dominant virus from the samples tested.

During this work, a new polerovirus referred to Phasey bean virus – PhBV (previously thought to be a strain of BWYV) has been identified from many hosts and locations in the northern region (Table 2). It is transmitted efficiently by cowpea aphid. Although the relative importance of PhBV in chickpea crops is still uncertain, it appears to have been responsible for approximately 30% of the infections thought to be BWYV in the 2012 virus outbreaks (Moore et al 2013).

Table 1. The percent infection of BWYV, AMV, BLRV and CMV from chickpeas displaying virus symptoms in northern NSW as determined by TBIA diagnostic. Virus identification based on antibody reaction. Sample locations shown roughly from north to south. Note that the BWYV infections may be a complex of related viruses. Samples from most locations were also tested for Turnip mosaic virus (TuMV) but no positives were detected.

<table>
<thead>
<tr>
<th>Location</th>
<th>Plants tested</th>
<th>% BWYV</th>
<th>% AMV</th>
<th>% BLRV</th>
<th>% CMV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boomi</td>
<td>6</td>
<td>100</td>
<td>0</td>
<td>^n/t</td>
<td>n/t</td>
</tr>
<tr>
<td>North Star</td>
<td>12</td>
<td>67</td>
<td>17</td>
<td>n/t</td>
<td>n/t</td>
</tr>
<tr>
<td>Moree</td>
<td>19</td>
<td>79</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Edgeroi</td>
<td>32</td>
<td>62</td>
<td>0</td>
<td>n/t</td>
<td>n/t</td>
</tr>
<tr>
<td>Edgeroi</td>
<td>17</td>
<td>47</td>
<td>0</td>
<td>n/t</td>
<td>n/t</td>
</tr>
<tr>
<td>Tamworth</td>
<td>15</td>
<td>60</td>
<td>20</td>
<td>n/t</td>
<td>0</td>
</tr>
<tr>
<td>Tamworth</td>
<td>30</td>
<td>87</td>
<td>10</td>
<td>n/t</td>
<td>0</td>
</tr>
<tr>
<td>Breeze</td>
<td>18</td>
<td>89</td>
<td>0</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Breeze</td>
<td>25</td>
<td>88</td>
<td>8</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Breeze</td>
<td>26</td>
<td>77</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Breeze</td>
<td>19</td>
<td>53</td>
<td>5</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Liverpool Plains</td>
<td>20</td>
<td>90</td>
<td>10</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Liverpool Plains</td>
<td>21</td>
<td>90</td>
<td>10</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Werris Creek</td>
<td>15</td>
<td>73</td>
<td>13</td>
<td>n/t</td>
<td>0</td>
</tr>
<tr>
<td>Pine Ridge</td>
<td>15</td>
<td>93</td>
<td>7</td>
<td>n/t</td>
<td>0</td>
</tr>
<tr>
<td>Pine Ridge</td>
<td>15</td>
<td>80</td>
<td>13</td>
<td>n/t</td>
<td>0</td>
</tr>
<tr>
<td>Blackville</td>
<td>15</td>
<td>13</td>
<td>67</td>
<td>n/t</td>
<td>0</td>
</tr>
<tr>
<td>Gilgandra</td>
<td>14</td>
<td>7</td>
<td>78</td>
<td>n/t</td>
<td>n/t</td>
</tr>
<tr>
<td>Gilgandra</td>
<td>38</td>
<td>21</td>
<td>71</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Gilgandra</td>
<td>49</td>
<td>12</td>
<td>88</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Wellington</td>
<td>30</td>
<td>10</td>
<td>73</td>
<td>n/t</td>
<td>n/t</td>
</tr>
<tr>
<td>Wellington</td>
<td>16</td>
<td>19</td>
<td>63</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Wellington</td>
<td>15</td>
<td>7</td>
<td>60</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Wellington</td>
<td>20</td>
<td>5</td>
<td>55</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

^ not tested (n/t)

Biology of significant viruses of pulses, particularly chickpeas

Accurate identification of viruses is critical for long term resistance breeding to be successful and for meaningful studies of how viruses survive in weed hosts and move into crops. To this end, we have begun to develop improved accurate diagnostics for the luteoviruses to help overcome uncertainty of virus identifications that can result from cross reactions of viruses to some antibodies. We have
used a PCR for *Beet western yellows virus* (BWYV), *Bean leaf roll virus* (BLRV), Phasey bean virus (PhBV) and *Soybean dwarf virus* (SbDV) to investigate host range of the virus species from a range of locations (Table 2). While testing continues, Marshmallow weed is commonly found to be infected with BWYV from many locations and burr medic is a host for BLRV, PhBV and SbDV.

**Table 2.** The identification of virus species in different plant hosts from different locations in the northern region confirmed by species-specific PCRs. Testing of selected samples from 2012 and 2013 surveys.

<table>
<thead>
<tr>
<th>Virus (by PCR or sequencing)</th>
<th>Plant host</th>
<th>locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>BWYV</td>
<td>Chickpea</td>
<td>Wellington, Breeza, North Star, Boomi</td>
</tr>
<tr>
<td></td>
<td>Canola</td>
<td>Ardlethan, Burren Junction, Bellata</td>
</tr>
<tr>
<td></td>
<td>Marshmallow</td>
<td>Wagga Wagga, Coolamon, Griffith, Hillston, Leeton, Narrandera, Wellington, Tamworth, Narrabri, Wee Waa, North Star, Goondoowindi, Grantham</td>
</tr>
<tr>
<td></td>
<td>Turnip weed</td>
<td>Gravesend, Wee Waa, Burren Junction</td>
</tr>
<tr>
<td></td>
<td>Sonchus sp.</td>
<td>Coolamon</td>
</tr>
<tr>
<td></td>
<td>Shepherds Purse</td>
<td>Kingsthorpe, Boomi</td>
</tr>
<tr>
<td>BLRV</td>
<td>Chickpea</td>
<td>Wellington, Edgeroi</td>
</tr>
<tr>
<td></td>
<td>Burr medic</td>
<td>Wellington</td>
</tr>
<tr>
<td>PhBV</td>
<td>Chickpea</td>
<td>Kingsthorpe, Boomi, North Star, Edgeroi, Burren Junction, Breeza, Horsham</td>
</tr>
<tr>
<td></td>
<td>Faba bean</td>
<td>Edgeroi</td>
</tr>
<tr>
<td></td>
<td>Burr medic</td>
<td>Boomi, Burren Junction, Wee Waa</td>
</tr>
<tr>
<td></td>
<td>Lentil</td>
<td>Breeza</td>
</tr>
<tr>
<td></td>
<td>Vetch</td>
<td>Kingsthorpe</td>
</tr>
<tr>
<td>SbDV</td>
<td>Chickpea</td>
<td>Wellington, Gilgandra, Breeza, Edgeroi, Bellata, North Star, Boomi, Clifton</td>
</tr>
<tr>
<td></td>
<td>Burr medic</td>
<td>Edgeroi</td>
</tr>
</tbody>
</table>

**Better agronomy – better chickpeas**

Field trials from 2012 and 2013 have shown that chickpea crops are at risk of increased damage from viruses when plant density is below about 20 pl / m² (Verrell 2013, Moore et al 2014). Significantly less plants are infected when plant densities are higher and it is recommended to aim for greater than 25 pl / m².

Trial crops deficient in N, K, P or all three have been shown to have significantly more virus affected plants than a crop with adequate nutrition (Verrell 2013).

Inter row planting into standing wheat stubble significantly reduced virus incidence in small trial plots of PBA HatTrick() when compared to the same amount of stubble slashed low to the ground (Moore et al 2014). The mechanism for this difference is unclear but these results are in agreement with many field observations by the authors in large crops during virus outbreaks.
While differences have been observed for the virus resistance of different varieties (Verrell 2013, Verrell 2014, Hawthorne 2008), further screening will be needed to strengthen confidence in these results under high disease pressure, from different regions, and to identify for which virus species resistance is effective. Under low virus pressure in field trials, some of the better performing varieties included Flipper© and PBA HatTrick© although both these varieties have been observed with high rates of infection under high disease pressure. Variety Gully is very susceptible to Ascochyta but has moderate virus resistance so may be useful for breeding resistance into future varieties.

While a link could not be confirmed in the 2013 season between BWYV infections in canola and subsequent spread into nearby chickpea crops (van Leur et al 2014), the sometimes high incidence of BWYV in canola indicates it may still be prudent to avoid planting chickpea and other pulse crops next to canola.

Conclusions
Visit http://www.pulseaus.com.au/pdf/Virus%20Contol%20in%20Chickpea.pdf for detailed information on reducing losses from viruses in chickpeas. Currently, the best strategies to manage chickpea viruses are agronomic ones:

- Retain standing stubble which can deter migrant aphids from landing. Where possible, use precision agriculture to plant between stubble rows. This favours a uniform canopy which makes the crop less attractive to aphids.
- Plant on time and at the optimal seeding rate of greater than 25 pl / m² – these result in early canopy closure which reduces aphid attraction (Verrell 2013)
- Ensure adequate plant nutrition
- Control in-crop, fence-line and fallow weeds – this removes in-crop and nearby sources of vectors and virus.
- Avoid planting adjacent to lucerne stands – lucerne is a perennial host on which legume aphids and viruses, especially AMV and BLRV survive and increase (van Leur and Kumari 2011).
- Seed treatment with systemic insecticides such as imidacloprid may be effective for reducing early infections of the persistently transmitted luteoviruses such as BLRV in faba bean, but is not effective for non-persistently transmitted viruses or for late infections of either virus type. Unfortunately, local data supporting seed treatment is lacking.
- Given the high incidence of BWYV sometimes found in canola, consider growing chickpeas (and other pulse crops) away from canola.

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References


Contact details
Murray Sharman
DAFFQ, Ecosciences Precinct, GPO Box 267, Brisbane, 4001
Ph: 07 3255 4339
Fx: 07 3846 2387
Email: murray.sharman@qld.gov.au
Reducing risk of virus disease in chickpea through management of plant density, row spacing and stubble – 2013 trials in northern NSW

Kevin Moore¹, Andrew Verrell¹ and Mohammed Aftab²

¹Tamworth Agricultural Institute, NSW DPI, Tamworth NSW 2340, Australia.
²Grains Innovation Park, DEPI, Horsham VIC 3400, Australia.

Key words

virus, chickpea, plant density, row spacing, stubble management

GRDC code

DAN00143, DAN00171, DAN00176, DAV00134

Take home message

Reduce risk of viruses in 2014 chickpea crops by planting between rows of standing cereal stubble, sowing on time and targeting at least 25 plants/m²

This paper should be read in conjunction with Sharman et al (2014) Viral diseases in chickpeas – impact and management, also in these proceedings. Our paper provides further detail on the effect of agronomic practices on the incidence of chickpea viruses in 2013 at two locations in north western NSW.

Introduction

Controlling virus disease in chickpeas is difficult. Chickpea plants that become infected with a virus invariably die. All current commercial desi and kabuli varieties grown in the GRDC Northern Region are susceptible to the main viruses in that region. GRDC funded field trials at the Liverpool Plains Field Station, Breeza in 2000, 2001, 2002, and 2003 showed no benefit of seed applied insecticides or regular foliar applied insecticides or a combination of both against chickpea viruses. The best and at this stage only, control strategies to reduce risk of viruses in chickpeas are agronomic. These include; retaining cereal stubble, sowing on time, establishing a uniform closed canopy, providing adequate nutrition and controlling weeds (Schwinghamer et al 2009, Verrell 2013, Murray et al 2014).

Effect of chickpea genotype on incidence of virus at Pine Ridge and Tamworth

Incidence of symptomatic plants of four desi varieties (Kyabra, PBA Boundary, PBA HatTrick and the advanced breeding line CICA0912) and one kabuli, Genesis™090 was assessed on 11 October 2013 in field trials at Pine Ridge and at Tamworth (TAI – Tamworth Ag Institute). Although the incidences of virus throughout the trial sites and, at Pine Ridge in the surrounding commercial chickpea crop, were relatively low (<10%), variety had a significant effect on incidence of virus at both sites (Figure 1). PBA HatTrick had the lowest incidence at both sites followed by Genesis090. The ranking of Kyabra, PBA Boundary and CICA0912 varied with site (Figure 1).

In a similar trial conducted in 2012, there was no effect of variety (the same ones as in this trial) on incidence of symptomatic plants. Accordingly, there is insufficient data to recommend using chickpea variety as a tool for reducing risk of virus.
Figure 1. Incidence (%) of chickpea plants with virus symptoms for four desis and one kabuli at Pine Ridge (top) and Tamworth (bottom) on 11 October 2013.
Plant density and incidence of plants with virus symptoms

In September/October 2012, viruses were common in chickpea crops throughout north central and northern NSW – almost every crop inspected had some level of virus (Moore et al, 2013, van Leur et al, 2013). Observations during that period suggested a link between plant density and incidence of virus; in addition, growers and agronomists reported a higher incidence of virus in chickpea crops with thin stands. In a 2012 trial designed specifically to examine the effect of plant population on chickpea viruses, Verrell (2013) found the highest incidence of symptomatic plants occurred at the lowest plant density (5 plants/m$^2$). Incidence declined in a curvilinear fashion as plant densities increased. However, there was no significant difference in the incidence of plants with virus symptoms for 20, 30 and 45 plant/m$^2$ densities.

Verrell’s 2012 trial was repeated in 2013 trials at two locations, one (Pine Ridge) in the virus prone region of the Liverpool Plains (van Leur et al 2003) and the other at the Tamworth Agricultural Institute (TAI), Tamworth. As occurred in the 2012 trial, incidence of symptomatic plants was greatest at the lowest sowing rate (5 plants/m$^2$) at both 2013 sites and declined as plant densities increased. However, there was no significant difference in the proportion of plants with virus symptoms at 20, 30 and 45 plants/m$^2$ densities.

![Figure 2](image-url)

**Figure 2.** Effect of plant density on incidence of chickpea plants with virus symptoms at Pine Ridge and Tamworth, 2013.

Row spacing and incidence of plants with virus symptoms

Row spacing had a significant effect on incidence of plants with virus symptoms in a 2013 trial at Tamworth. On 11 October 2013, there were more than twice as many symptomatic plants/m$^2$ in plots with 40cm rows compared to those with 80cm rows (Figure 4). Both row configurations were sown at 30 plants/m$^2$ so plant density per unit area cannot account for the difference. Rather, plant density within each row appears to be responsible (12 plants/m row @ 40cm and 24 pl/m row @ 80cm).
Stubble management and incidence of plants with virus symptoms

Planting into standing cereal stubble is known to help reduce risk of virus in lupin crops (Jones, 2001). Retaining standing winter or summer cereal is believed to be useful in reducing risk of virus in chickpea crops (Schwinghamer et al. 2009) although van Leur et al. (2013) found no relationship between stubble loading and incidence of virus in a quantitative survey of viruses in 2012 chickpea crops on the Liverpool Plains. However, we are not aware of any experimental data from trials designed specifically to examine the effect of stubble management on incidence of virus in chickpeas in the GRDC Northern region.

Two trials were conducted at Tamworth in 2013 to compare standing versus flat (slashed) wheat stubble on incidence of plants with virus symptoms. One trial was sown at 80cm row spacing; the other at 40cm spacing; both were sown with PBA HatTrick chickpea at 30 plants/m². The 80cm trial was assessed on 11 October and the 40cm trial was assessed on 9 October and again on 16 October. In both trials, incidence of plants with virus symptoms was lower where the chickpeas had been sown into standing stubble (Figures 4 & 5). Individual plots in these trials were small, 2m x 10m for the 80cm trial and 4m x 10m in the 40cm trial. This raises the question: “If the vectors have no choice ie the entire paddock has standing stubble (or not), is stubble management still a useful tool for reducing virus risk?” Based on our own and other’s observations in commercial crops, we believe the answer is Yes; but further research is needed.

Virus species in Pine Ridge and Tamworth trials

Chickpea plants with symptoms of virus infection were sampled for virus testing by Tissue Blot Immuno Assay (TBlIA). At each sampling time, 15 symptomatic plants were collected and tested for Alfalfa mosaic virus (AMV), Cucumber mosaic virus (CMV) and Beet western yellows virus (BWYV). At Pine Ridge, 15 symptomatic plants were also tested from the surrounding crop of Almaz(1)
chickpeas. In addition 15 asymptomatic (healthy, turgid, vigorous, green plants) were also tested from each trial and the Almaz crop. By far the most common virus was BWYV, accounting for 65 – 94% (mean 83%) of symptomatic plants; 12% of symptomatic plants were positive for AMV; CMV was not detected in any symptomatic plants; only one (out of 105) plant was co-infected with BWYV and AMV. None of the 45 asymptomatic plants tested positive to any of the three viruses.

![Figure 4](image.png)

**Figure 4.** Effect of stubble management (flat vs standing) on incidence of chickpea plants with virus symptoms, Tamworth 2013.

![Figure 5](image.png)

**Figure 5.** Effect of stubble management (flat vs standing) on incidence of chickpea plants with virus symptoms assessed on two dates, Tamworth 2013.
Conclusions

- Sow at the optimal seeding rate - irrespective of sowing date
- Plant on time
- Retain standing cereal stubble and sow between the stubble rows

References


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Contact details

Dr Kevin Moore & Dr Andrew Verrell
NSW Department Primary Industries, Tamworth
Kevin: 02 6763 1133; 0488 251 866; Andrew: 0429 422 150
Email: kevin.moore@dpi.nsw.gov.au, andrew.verrell@dpi.nsw.gov.au

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